AMERICAN MACHINIST

A JOURNAL FOR MACHINISTS, ENGINEERS, FOUNDERS, BOILER MAKERS, PATTERN MAKERS AND BLACKSMITHS.

VOL. 11, No. 34. WEEKLY. | NEW YORK, AUGUST 25, 1888. | $2.50 per Annum. SINGLE COPIES 5 CENTS.

COPYRIGHT 1888, BY AMERICAN MACHINIST PUBLISHING COMPANY.

For Sale Everywhere by Newsdealers.

ENTERED AT POST OFFICE, NEW YORK, AS SECOND CLASS MATTER.

New Boring and Turning Mill.

The accompanying engraving is of a 37-inch boring and turning mill recently brought out by the Bridgeport Machine Tool Works, of Bridgeport, Conn.

During a recent visit to the works we saw the first machine of this design belted up and tested for accuracy by facing off its own table, and for driving power an strength by taking heavy cuts on a casting, both of which tests it bore in a very satisfactory manner. The bed was faced with great accuracy, as shown by a test with a standard hardened straight-edge and bits of thin tissue paper, and the heavy cuts taken showed its driving power and stiffness to be ample for any work coming within its range.

The engraving gives a very good idea of the general design of the tool, and shows it to be heavy and very substantially proportioned, the cross-rail and tool-bar being wide, and provided with ample bearing surface.

Work 27″ diameter and 24″ high can be handled on the machine, and there are 20 changes of speed, ranging from 2 to 60 revolutions per minute.

The head, which carries the tool-bar, can be set at any angle, and has a traverse of 18″, with a quick return by means of a rack and pinion and hand-wheel. At each end of the rack there are a few teeth removed, leaving a gap into which the pinion may run, and thus the danger of breaking the teeth of the rack or pinion, by running to the end of the rack, is avoided. There is also a locking device for the bar, by which it is readily held so as to prevent vertical motion when taking facing cuts.

The feed is automatic in all directions, and ranges from $\frac{1}{32}$″ to $\frac{3}{8}$″ horizontally, and from $\frac{1}{48}$″ to $\frac{1}{4}$″ in angular and vertical directions. It is under full control when the machine is in motion.

The lower part of the tool-bar is bored out and forms a split sleeve, into which is fitted the piece having the rectangular head and set screws for holding the tools. This arrangement admits of the bar being extended 8″, and also allows of the tool being swung round at any desired angle to bring it above or below the center. The slot for holding tools extends across the bottom of this head as well as up each side, so that a tool may be held at either side vertically, or across the bottom horizontally.

All gears are cut, including the large bevel gear which is under the table and its pinion, which are planed upon a Gleason machine. The pinions on the cross-shaft used for raising and lowering the rail are of forged steel, and the worm-wheel back of the rail, which receives its motion from a worm on the vertical feed shaft, is a wrought-iron casting, case-hardened. This vertical shaft is driven at a comparatively high speed, to give power to the feed motion, which is reversed by means of the bevel gears and double-ended clutch, operated by the lever shown at the bottom of the vertical rod. The feed motion is positive, being driven by cone gears, and changes in rate of feed are made by an "in-and-out" pin. The entire feed train can be thrown out of action when desired, by slipping a gear on the main driving spindle.

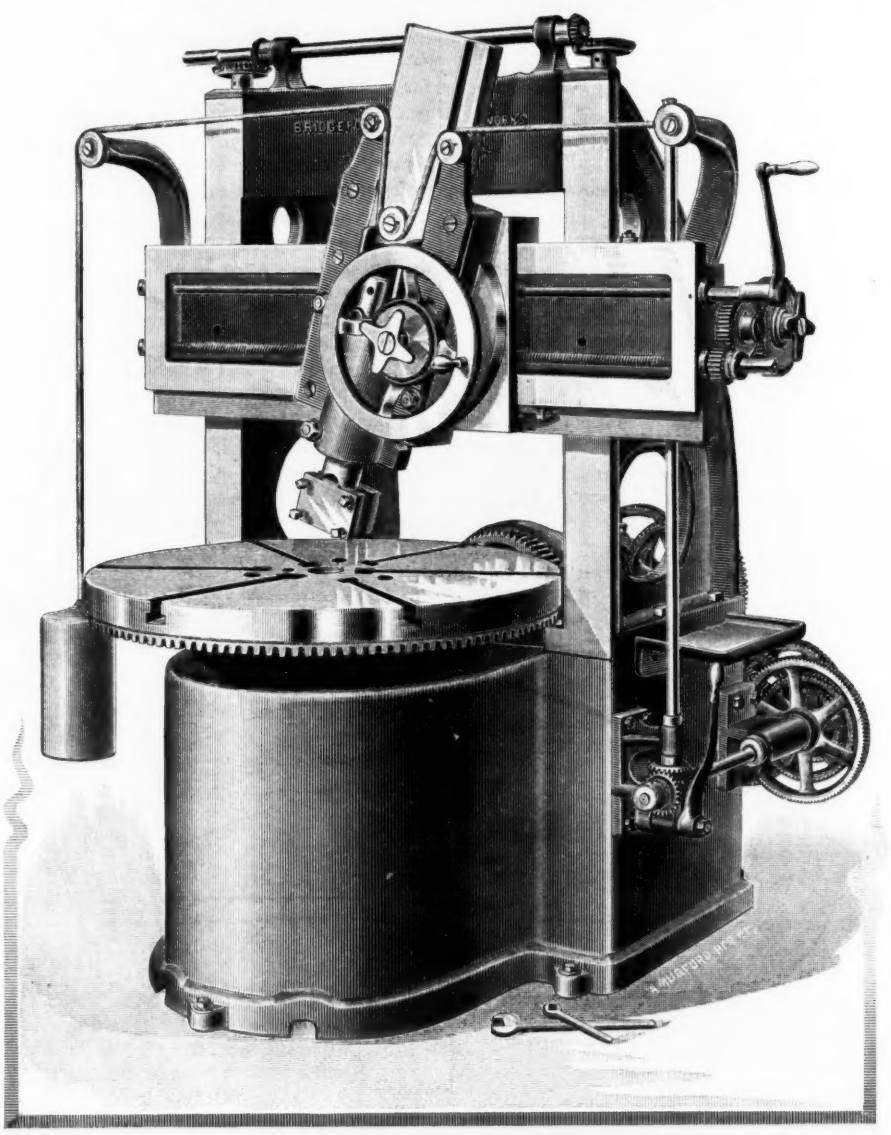
The spindle upon which the table runs is 26″ long, having a lower bearing 6″ diameter, 6″ long, and an upper bearing 7″ diameter, 12″ long. Above this latter bearing is another one, which is bored at an angle, and is for supporting the weight of table and work. The amount of surface in this bearing is calculated to be sufficient to prevent the forcing out of oil from between the surfaces if the table should be loaded with a solid block of iron as large as the mill will swing and twice as high as will go under the rail at its highest point.

The ends of the cross-feed screw and rod have thimbles keyed on them, to increase the size of their bearings and the collars which take the end thrust. Two shelves are provided, one on each side, for the reception of tools, wrenches, etc., used about the machine. All sliding surfaces are scraped to a bearing, and taper wedges used as gibs.

A system of jigs is used in the building of them, and the parts are, in consequence, largely interchangeable, and the workmanship is first-class. The machine is built with two heads when so ordered. The countershaft has three pulleys 16″ diameter, 6½″ face, and should run 150 and 185 revolutions per minute, both forward. Weight, complete, 6,000 lbs.

As to the methods pursued in the manufacture of this machine, to secure accuracy, and first-class construction, we shall have something further to say at a future time, in describing some of the things seen in the shop where they are built.

Pennsylvania miners are bringing suit to secure semi-monthly pay, as provided by law.



NEW BORING AND TURNING MILL.

Force in the Steam Engine, and its Relation to Smooth Running.

BY PROF. JOSEPH E. TORREY.

SECOND PAPER.

In the first paper it was shown that steam ought to be so distributed in the cylinder of a steam engine as to make the shock on passing centers as small as possible. It was seen that lead and compression acted in that direction by setting up a gradual resistance to the progress of the piston near the end of the stroke, and thus making the transference of pressures from end to end of the piston more easy and gentle. It was also shown how the magnitude and distribution of the steam forces on both ends of the piston, throughout the whole stroke, could be studied by the indicator diagram. A few more examples are given on page 2, by way of showing the forms of diagrams given by some familiar engines. These diagrams were all given me, except Fig. 4, which was taken by myself. They were collected in the course of half an hour's walk in Boston. It is needless, perhaps, to say that they were selected entirely at random, and are not in every case good cards.

Figs. 1, 2 and 3 are from representative high-speed engines, and Figs. 4, 5 and 6 are from low-speed engines, the speeds ranging from 68 R.P.M., in Fig. 6, to 280 R.P.M., in Fig. 3. They are all reduced from actual size as taken. The area of opposing pressures represented by the small triangle *a* varies about as the speed in the cards here shown.

One thing of interest may be here noticed, namely, that if the triangle *a* in any card (representing force *opposing* the piston motion) be spaced off and "worked up," like a whole indicator diagram, the result will be the *average opposing pressure*. If the irregular-shaped portion *b* be worked up in the same way the result will be the *average propelling pressure*. The difference between these two results will be the M.E.P. of the card. It is more rapid and easy to divide the area lying between the expansion, back pressure and compression lines, into the desired number of spaces, and proceed to determine the area; although in dealing with one diagram only, the more accurate way would be to find the two areas and subtract, as indicated above. Usually, however, the whole card is worked up, and in the average these errors disappear.

It happens in this case, although it will not always, that the diagram where the shocks are apparently the greatest was from the only noisy engine in the lot. The engineer assured me that he had "tightened her up" as much as he dared to, but she would pound. The main trouble was that the "pound" had not been located correctly. It was actually in the main journals, and since the tightening had all been done at the crank and crosshead pins, nothing had been accomplished. There was a heavy and violent shock at each reversal, and the main pillow block was quite loose on its foundation. Correct valve setting would certainly have done considerable toward preventing this state of things.

Fig. 5 requires some comment. It will be seen that the compression is very heavy—full as heavy as in any of the high-speed diagrams. This engine really ought to be classed as *medium* speed. It was one of a pair of engines—about 18″×38″, I should think—the data is not on the card—making 100 R.P.M.

In adjusting the valve gear of any engine, considerable judgment is needed. There are many points which need to be carefully considered. On very general principles the following hints may be useful to young engineers: 1. In low-speed engines the closure of the exhaust is more rapid with reference to the piston motion than in high-speed engines, and consequently compression should generally begin later in the stroke. Lead, also, should be kept within rather narrower limits. 2. The form of exhaust and steam valves used will also be of importance. If a flat valve is employed for admission, unless it is

held to its seat by a cover plate, or some similar device, there is always danger of springing the valve by heavy compression, or even forcing it from its seat. The writer has recently seen a case where the steam valve was lifted from its seat at each end of the cylinder, and at *every stroke*, by compression. No one seemed to know what was the trouble. 3. Clearance should be known and considered. In general, engines with large clearance space carry heavy compression beneficially. Finally, it is a good plan not to attempt to adjust valve gears without the indicator. Setting valves by reference to prick-punch marks is *not* a good plan at all.

In judging an engine as to its smoothness of running, it is often a very important question how near its rated load said engine is working. One of the most important "forces" having intimate relation to smooth running is not a "steam force," or an "inertia force," but *the force of circumstances*. I do not think steam power users meet the manufacturers half way in this matter. It seems to be a very well recognized fact among the best engine builders—especially such as build engines with independent exhaust system—that in order to get the best results in running qualities, as well as steam economy, the engine should work as near as possible to her rated load, but steam users are too apt to err in either buying too large an engine or too small a one.

With this brief survey we will leave the steam forces for the present. What study remains to be done on them can best be done in connection with the "inertia forces," which will be next considered.

Shop Notes.

BY JARNO.

No. 10.

HOW GASCON TESTED WIND PRESSURE.

Gascon had a blower that he wanted to sell. It was set up near a forge in his shop. To it he had attached a piece of hose, as seen in the figure. Gascon's competitor, Labrihed, called. Gascon commenced to show up the good points of the blower, among them being its power to change air into wind. The blower was not made by a well-known maker, and of course it required more showing up than blowers that are made by well-known makers.

To show up a blower, Gascon is well fitted, both by inheritance and by education. He started up his blower and made a few graceful movements of the hose, not being over-particular as to which direction it was pointing.

Labrihed said: "Gascon, if you expect to impress me favorably either with yourself or your blower, you must change the direction of that hose. My ear has already got quite an unpleasant sensation from that blower of yours. I am not accustomed to have my ear used for a wind gauge. Before I again come into your shop I shall have printed on my ear, 'This is not an anemometer.'"

Gascon made a mental survey and decided that it could be done, while Labrihed continued:

"Were I to understand anything of your blower that would be of value, I should have to know the height of a column of water that the wind from the blower will support."

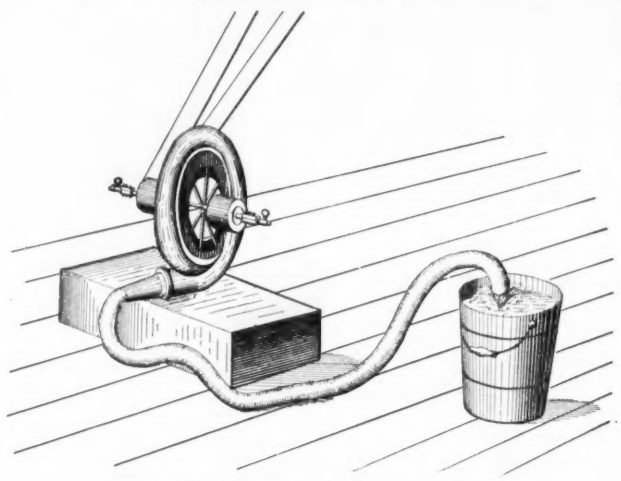
Labrihed had said this because he supposed that the wind pressure was the only point or datum that Gascon could not give.

Hardly had the words "height of a column of water" been spoken, before Gascon had plunged the end of the hose into a pail of water standing near his forge.

He dropped the hose down until bubbles just ceased coming out from the end of the hose into the water.

Then, putting his thumb to the top of the water, and holding it against the side of the hose, he took the hose out of the water, and measuring the length of the wet part, he said: "That is the height of the column of water that the wind from the blower will support."

A little consideration will show that the height of the water around the hose, when the air bubbles just ceased coming out, was really the height of the column of water that the pressure of wind from the blower would support.



How Gascon Tested Wind Pressure.

Gascon does not go into the refinements of mechanical engineering, but there are a few principles that he has thoroughly learned. These few things he would know if suddenly waked up at two o'clock in the morning. He can apply them as easily as he can use his jackknife.

Longitudinal Cracks in Bar Steel.

BY T. P. FARMER.

Bar steel, as purchased in the open market for the purpose of converting into small tools, is, generally speaking, all right, and it is probable that many factories consume tons of it year after year, without discovering any serious defects. I once purchased, through the persuasion of a manufacturer's agent, for trial, twenty-five bars of an imported brand of round tool steel, $\frac{1}{2}''$ and $\frac{5}{8}''$, and made a discovery which at the time seemed phenomenal. Now, the great advantages set forth in the use of this particular brand were, that it required no annealing, being soft and ready to work, and its great tenacity and peculiar hardening qualities.

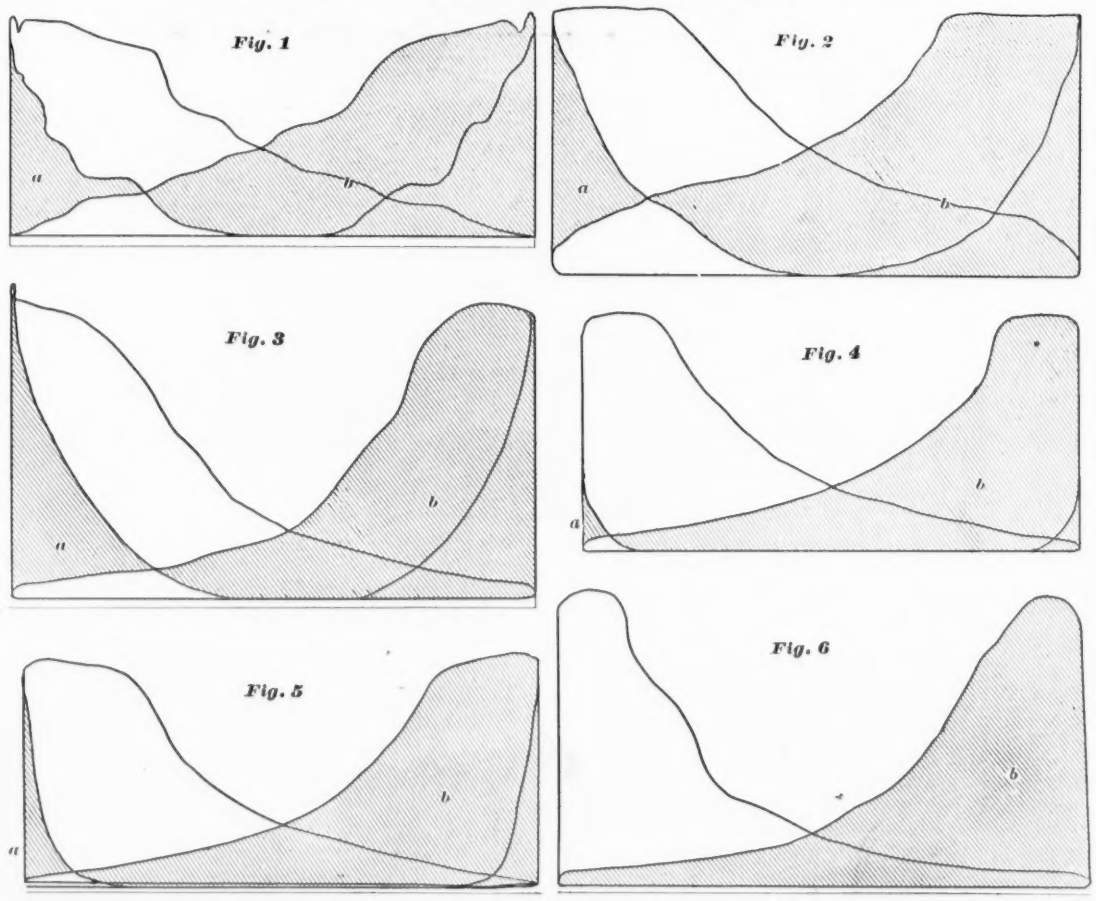
Before cutting this steel up preparatory to making a certain line of goods, it was found that some special taps were needed in the shop, and four were made from a piece cut from one of the $\frac{1}{2}''$ bars; they were carefully made, and tempered by an experienced hand, but when put to use all four of them split. Such a coincidence was surprising, and naturally called for an explanation, and, upon close examination, a straight lengthwise crack was plainly visible from end to end of each tap. In three of them the crack passed through one of the grooves and up the shank, while in the fourth it ran directly through the threads; the edges of the fractures were so identical, and the line so straight, that, when the taps were placed one before the other, it was continuous.

Ordinary "fire-cracks," or "water-cracks," as some term them, are not usually so straight for so long a distance, but have a zigzag appearance; so there seemed little reason to believe the damage could be attributed to the time of hardening. I had pieces cut from different parts of the same bar, and from various tests, both before and after hardening, proved beyond doubt that the crack extended throughout its entire length, and in depth nearly to the center. From all outward appearance this bar of steel seemed sound, there being neither ridge or seam to cause suspicion, and, after turning and polishing a piece, no trace could be discovered, even with the aid of a powerful glass; but by breaking parts of the bar over the anvil, the *straight* edges of the fracture, with a slight line of oxide on the inner side, told the story; after hardening, the defect could readily be seen with the naked eye.

Now I will not ask that oft-repeated question, so many times answered in these columns, "Does steel contract or expand in cooling?" but I would like to know just what it *does do* when it leaves the rolls. The agent, in his efforts to smooth matters, informed me that the trouble lay entirely in defective rolls, but I doubt it; he also advanced the theory that some of the bars, as they came from the rolls, were placed on the cold stone or brick floor of the mill, thereby causing a sudden contraction on one side; this I also doubted. He wanted me to test the other twenty-four bars. I refused to do so, but I did test six of them, and found one more as defective as the first, making two out of seven.

It is needless to say that I never used this steel, and the agent never requested the payment of his bill, although I believe him to be perfectly honest, and this one occurrence a departure from his usual experience; but, under the circumstances, what could he do? I did not dare to use his brand of steel, and he knew it. What do I think caused these cracks? I would not like to say, for I believe it is a question that could be better answered and explained by the chemist than by the mechanic.

I had placed in my hand, a few days ago, a reamer, made by one of the best manufacturers in the country, that had a *straight* crack through its entire length; it was shown me as a curiosity, having done good service for a long time, and as I looked at it I wondered if the crack was in the bar from which that reamer was made. Who can tell?



Indicator Diagrams.—See Page 1.

Globe Valve Patterns.

BY F. W. BARROWS.

FIRST PAPER.

These patterns may be divided into three classes, as follows:

1. Iron valves above 6″ in size. Patterns and core-boxes both made of wood, the core-boxes made with loose seats, from 6″ up to 12″. It may be well enough to make whole core-boxes, to save changing seat, which wears out the boxes very fast. Above 12″ a half box so made as to change for the two halves of core, and also to change for making the angle, safety and cross valve of the same size, although a safety valve of this size would be a rare thing. Still, the same change which makes the angle valve would also make the safety or cross, so that, when we have so arranged the pattern and box that we can make an angle valve, we can, by the addition of another branch on pattern, make either one of the others.

2. Iron or brass valves from 6″ down to 2″. Patterns for these may be made of wood, pine, or perhaps something more durable, if the number of castings to be made will warrant the extra expense. Core-boxes for these sizes may be made of iron, in two parts, from either wood or plaster of paris patterns.

3. Iron or brass valves from 2″ down. These, especially the brass valves, are usually made in such quantities that it becomes necessary to make the patterns of metal, generally of brass, and to have enough of each size and kind to fill a flask. They are all fastened together by gates, or are fastened in halves on a plate, and moulded in a "squeezer."

I shall consider nothing but the bodies of the valves under these heads, and for the first class will describe a 16″ globe and angle combined.

The first requisite is a reliable working drawing. This *may* be furnished, but it is usually left to the pattern maker to make his own working drawing, and he generally makes a full size, sectional view on a piece of board. To the credit of the craft be it said, that the pattern maker who can make a pattern from a scale drawing is also competent to make a working drawing of the same.

As we are going to construct a 16″ flanged valve (flanged valves only will be required of this size, because the steam pipe makers haven't put any 16″ wrought-iron pipe on the market as yet—12″ is, I believe, the largest to be had),

we shall want a full-sized drawing like Fig. 96.

Now, it is not very likely that there will be many globe valves of this size required, and as the pattern will be rather expensive, we had best make it in such a way that it will do for both globe and angle valves of this size, more especially as the same trimmings, with the single exception of the spindle, will do for both valves. Having arrived at this conclusion, let us see what modifications may be necessary to adapt the pattern to either form. The globe valve receives steam, water or gas at one end and discharges the same at the opposite end, the inlet and discharge pipes being in the same line. The angle valve has the inlet directly under the spindle, and the outlet at one side. Thus the line of pipe will form a right angle where it passes through the valve. In Fig. 97 I have given a sectional view of an angle valve body to be made from the same pattern and core-box we shall make for the globe valve shown in Fig. 96. By comparing the two, it will be seen that one of the branches must be movable, in order that the three branches or ends necessary on each valve may be placed in the relative positions shown by the two Figs. 96 and 97. As it is customary to make the body in the form of a globe, the best way to construct the body will be to turn it up as a complete globe and then fit the branches to the surface. After the branches are once fitted to the surface of this globe, they may be fastened on in any position required.

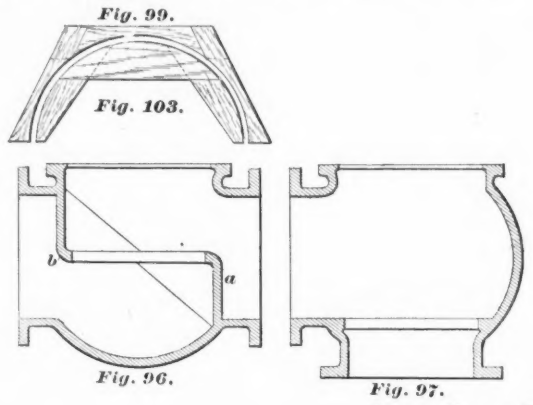
As a globe valve of this size will require for the body a ball from 24″ to 28″ in diameter, it is evident that it would not be good policy to make the pattern solid, because it would be very heavy, and we should also be obliged to fasten the branches from the outside, thus marring the surface of both the branches and the body. Therefore it will be best, for all reasons, to lay this ball up in cants or segments. This will make the pattern light and strong, and at the same time give us a good chance to fasten all the branches from the inside.

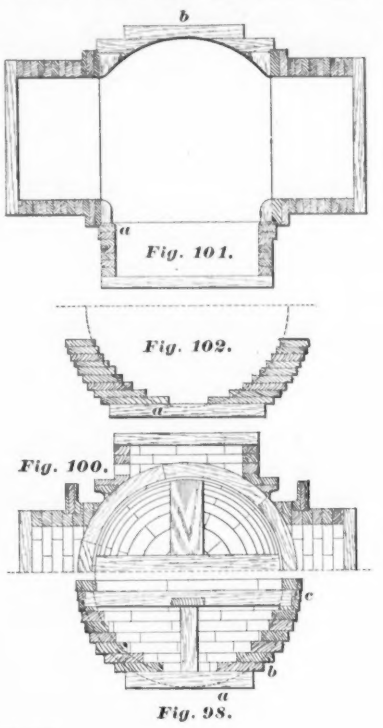
By referring to Fig. 98 the manner of building up this ball will be plainly seen. We start with a round plate, as shown at *a*; screw a face plate to one side of this, and face off in the lathe ready for the first course of cants marked in the figure *b*. Work the halves of the ball along together, and while waiting for the glue to dry, get out four pieces for braces or arms, as long as the diameter of ball, and having a cross-section about 2″ x 4½″. These should be halved together at their centers, forming two crosses, one for each half of pattern. When you get the halves of the ball built up to the course marked *c*, rough out the inside to such size and shape as will leave it, when finished outside, about 1¼″ thick. Then cut in the braces, leaving some thickness of wood outside their ends. Put a couple of good screws into each end of each arm, and also set up a support under the center of the crosses.

Now put each half back in the lathe and face off for the next course, and also face up a spot at the center, large enough to receive a face plate. Mark the center exactly, then go on and finish gluing on the last courses; lay these aside, to let the glue get thoroughly dry before turning them up.

In the meantime we will get the branches started. These will be best made up of courses. Begin with a solid head, which will form the end of core print. Get the gluing up done and lay them aside to dry while turning the ball. For this you will need an accurate templet, and I would recommend making one as shown in Fig. 99, which will neither warp nor shrink out of shape. Change the face-plate to the opposite side on arms. Don't begin turning by facing off the joint and then bringing the surface of the ball down to match, but first bring the surface down to fit your templet, then turn off as much or as little as may be necessary at the joint. It is much easier to take off an eighth of an inch here than to turn it off the whole surface of the ball. Be careful to get the halves of the body exactly the same size, as it will make a good deal of trouble if one is larger than the other; they won't match, and the branches won't fit.

Cut the branches in halves and make the joint before turning. Here you must be very careful again to locate the joint exactly in the center. You can't fasten them on the globe so that the parting will be flat, unless both the body and branches are all parted on the center line.





Globe Valve Patterns.

The flanges at each end had better be made separate and put on with screws, so that they may be changed if necessary.

Now let us put our pattern together, as the turning is finished. Fit dowel pins in the halves of globe, to keep the pattern in place while moulding. Fasten a block on top of arms in drag-half of pattern, find the center, and draw a line through this center. This will fix the position of the inlet and outlet branches. Fasten on these two branches, being very particular to keep the centers of both body and branches all in the same straight line. We can now locate the yoke end midway between these branches and at right angles with them. This is also a place where accuracy is very desirable, if you wish the core to fit nicely, as the core is liable to be laid in the mould either side up, and it is evident that it won't reverse unless the yoke end of both pattern and core-box are central between the two side branches. Another reason: When it is central it is also at right angles with the center line of branches; and, *vice versa*, when it is at right angles with this line it is also central. This follows from the mode of construction. Fig. 100 shows the pattern complete. Fasten on all the branches with plenty of screws, and you will have a good, strong pattern, and one that will mould nicely. Put a good, stout rapping iron in each half of pattern for the amusement of the moulder. I once worked under a foreman who was wont to say at times when the moulder had done something especially exasperating: "There never will be any moulders in heaven, because they are past all redemption." I don't believe this is literally true; still, it may be well to imagine so, when putting in rapping irons, and get in a few extra screws on that account, for the moulder is a trifle too willing to exercise his muscles.

And now let us take the core maker into consideration and see if we can construct a core-box that he won't be obliged to entirely demolish in order to separate the core from the box. Perhaps the gentleman referred to above included the core makers with the moulders in his harsh statement in regard to their final disposition. I presume he did, for he must have noticed, as we all have, that the average core maker does love to linger around a big core-box and see in how many different places he can strike it with the heaviest sledge around the place. We must take all of this into account, and make our core-box strong enough to stand a good deal more banging than is necessary.

We must also provide some way of moving each side branch round opposite the yoke end, in case we wish to make a core for an angle valve. This will compel us to make three sides of the box just alike, the remaining side being the yoke end.

The best way to make this box is to build it up in segments, as we did the pattern; but, in order that it may not become a creature of circumstance, and an eyesore, let us settle how we shall put the box together, then after this we shall be able to so build the body and branches that they may be easily fastened together, and make a strong box after being so fastened together.

Swing Cut-off Saw.

Perhaps the best way will be to construct it like Fig. 101. This gives us a square center piece as large as can be made conveniently, then there is a good flange on each branch. By means of screws through these flanges, we can fasten the branches onto the body part of box, and make a good, workmanlike job, which will show the forethought and constructive ability of its maker. By the way, pattern makers are too apt to let a job "develop itself," and many a botch has been made in this way. A little forethought would generally prevent this, but the lack of it keeps many otherwise good mechanics down at the bottom of the ladder.

The first thing in order will be to find out how large we must build up the center of box to make it finish to the size and shape shown by Fig. 101. This can be got at by laying out a full-size section of valve body, or you may put the necessary lines on the drawing you already have.

As the central part of box is approximately a sphere, it is evident that, if a slice be cut off the outside, the resulting face will be a circle or nearly so; then, if we know the size of the circle necessary to match flange on branch, and also the distance from the center of globe at which the joints between body and branches must be formed, we shall then be able to lay out the diameter of outside of central part of box.

Let us fix on the diameter of flanges necessary. The inside of neck of valve is 16″ in diameter; add to this double the thickness of stuff necessary to form a good, substantial core-box, say about 2½″, then a flange about 1¼″ wide. This makes the flanges 23½″ in diameter. For convenience we will make the joints on all four sides of the box at the same distance from the center. In fact, three of them would have to be alike anyway. We should locate the joints as far from the center as one-half the diameter of flange found necessary, if possible; otherwise we don't get the full benefit of the flanges in putting on the branches.

The actual distance of the joints from the center will be governed by the point at which we shall find ourselves obliged to locate the joint on the yoke end of valve. This neck, as will be seen by referring to Fig. 96, has a narrow internal flange or shoulder. This is without any question the proper place for a joint. We shall need all the room this distance from the center will give us; in fact, the radius of this point and the radius of the required flange will be seen to be nearly equal.

Make the joint just where the neck begins to narrow down to this flange. Draw a line through this point parallel with the center line of branches, and lay off on this line, measuring each way from the center of neck, the diameter of the flange. Now place one point of the trams at center of globe, and scribe a circle of such size that the circumference shall pass through the points, marking the diameter of flange on branch of core-box. This circle will be the circumference of a sphere, which, if cut by a plane at a distance from the center, equal to the radius of a circle to which the line marking the joint between body of core-box and the branches is tangent, the resulting face will be a circle of the same diameter as flanges on the branches of core-box.

Now that we have found the diameter of the sphere necessary for our purpose, let us begin to make it. First, we want a plate, round, and of the thickness and diameter shown by *a*, Fig. 102. On this foundation we will build up the segments, as shown in Fig. 102, taking care to make good joints between courses, especially on the first courses, where we shall have very thin edges after the box is finished. Put on about six courses, then make a templet like that shown in Fig. 103. This one should be cut to fit inside the required circle, instead of outside, like the one shown in Fig. 99, but it should be made of three pieces, to keep the circle true.

Swing Cut-off Saw.

The engraving of swing cut-off saw represents one manufactured by E. & B. Holmes, Buffalo, N. Y. The frame of the machine is cored to make it as light as consistent with strength, and is provided with a counterbalance, which provides for an easy pendulum movement.

The yoke that carries the saw arbor is cast separate from the main frame, and is held in position by a clamping device that permits the operator to raise or lower the saw at will. It also enables him to square the saw without disturbing the fence or guide.

The saw is adjusted by rack and pinion. To permit of such adjustment without altering the length of the belt, there is a swing tightener attached to a frame, which keeps the belt at the proper tension.

Irregular Pitch Lines.

By Geo. B. Grant, Boston.

Gear wheels with irregular pitch lines are of frequent application in mechanism, to produce a variable speed or power. Their most common use is to produce a simple variation of speed, from a certain maximum to a certain minimum, without reference to the variations between the limits, as in quick return motions for shapers, shears, etc., but occasionally it is necessary, for special purposes, to consider the speed at several points of the revolution of the gear.

THE GENERAL CASE.

We can best treat the irregular pitch line in its most general and unconfined condition, before considering any of its special applications or peculiar forms.

The irregular curve A of figure 1 revolves on a fixed center a, and its outline is arbitrary. It drives another irregular wheel B, revolving on the fixed center b, and the shape of this second curve will be so dependent on that of the first that it can be constructed from it by the following process.

With a pair of dividers set to some small stepping distance, step off the points c, c, c, on the given curve A, beginning at the line of centers $a\,b$. From the center a draw arcs of circles from the points c, c, c, to the line of centers at the points d, d, d. From the given center b of the required mating curve B, draw arcs of circles $d\,n$, $d\,n$, $d\,n$, from the points d on the line of centers. Take the same stepping distance as before on the dividers, and step off on the lines $d\,n$, from line to line in regular order, from the point of the curve A that is on the line of centers, and thus form points e, e, e, on the desired second or derived curve.

These two curves will roll together, and if provided with teeth will act as the pitch lines of gear wheels.

Their point of contact will always be upon the line of centers $a\,b$, shifting upon it but never leaving it.

The relative speed, or velocity ratio, at any time, will be in the proportion of the two radiants $a\ c$ and $b\ e$, drawn to two corresponding points on the curves, for those two points will come together at the line of centers.

There is no definite rule for forming a pair of irregular pitch lines that shall have speeds varying in any designated manner, and such lines can only be found by experiment. A line is first drawn according to judgment and its mate found by the given process. Knowing the action of the pair thus constructed, judgment will suggest such changes as will give another pair that will act more nearly as required.

CLOSED IRREGULAR PITCH LINES.

If we have a complete and closed irregular pitch line A, figure 2, the mate B, formed by the above process about a given center b, will in general not be closed, but will cross itself and will not practically work with the first curve.

But, by repeated trials, a center can always be found about which the derived curve will be complete and closed, and the two will then be fitted to run together in continuous rotation with an irregular speed.

SETS OF MULTILOBES.

If, after forming the first complete derived curve, the centers are still further separated, the derived curve will again cross itself, but a second center can always be found about which the curve will again be closed, and the two halves of its outline will be exactly alike. Similarly, by continuing the process, we can form derived curves having three, four, or more similar parts. As the primitive curve generally has a distinct projection or lobe, the derived curves will have several such lobes, and may be called multilobes.

Figure 3 is an example of the set of derived curves that can be formed from a given primitive curve, on centers on both sides of the primitive center.

From the primitive curve a_1, on the center b_1, is formed a unilobe A_1 on the center B_1, a bilobe A_2 on the center B_2, and a trilobe A_3 on the center B_3. If the center is set at n, of any lobe, are equal. The difference between the first and central radiants is constant throughout the system; $b_1\ q - b_1\ C$, $B_3\ m - B_3\ w$, $b_3\ x - b_3\ y$, etc., being equal.

If all the curves are fixed on their several centers they will roll together collectively, the common point of contact shifting along the line of centers. Therefore the several curves are mutually interchangeable, so that any curve will roll in internal contact with any curve of the same set, and in external contact with any curve of the other set. We can thus form trains of multilobes, as in figure 4, when their forms do not cause them to interfere with each other.

When it so happens that the first derived curve is exactly the same as the primitive curve, the two sets will be exactly alike, and we shall have a set of multilobes that will be mutually interchangeable, any curve rolling, internally or externally, with any other curve. See figure 5.

SALIENT POINTS.

The occurrence of salient points, or interruptions of the continuity of the curvature, as at q, figure 3, does not interfere with the theory of the curves considered as rolling pitch lines, but, for practical purposes, such breaks should be carefully avoided.

When providing the irregular pitch line with teeth, which must be done before it can be applied to any practical purpose, it is necessary to place a pitch or springing point of a tooth at every such salient point, to preserve the perfect continuity of the tooth action. As it is practically impossible to spring two teeth from the same point on the pitch line, irregular gears with salient points can turn in one direction only, and are objectionable on that account.

IRREGULAR BEVEL GEARS.

The preceding processes will apply as well if the figures are drawn on the surface of a sphere, and therefore we can have bevel gears, as well as spur gears, in the form of multilobes.

SPECIAL CASES.

Although any arbitrary curve will serve as the base or primitive curve for a set of multilobes to be derived by the method of figure 1, yet it is better to adopt some curve that can be easily handled, for the method is difficult to apply.

LOGARITHMIC MULTILOBES.

The logarithmic spiral is one such special curve that is subject to definite laws of construction, but, as any closed curve based on it must have salient points, it is practically objectionable.

THE CONIC SECTIONS.

Any conic section will roll with its equal, both being fixed on their foci, but the ellipse is the only one that will permit a complete revolution.

ELLIPTIC MULTILOBES.

The simplest irregular curve is the ellipse, and as it is easily handled, it is by far the best one to use for this purpose. It is a continuous closed curve, and its multilobes have no salient points.

In some cases it is necessary to consider the rate and peculiarities of the irregular motion produced, but generally it is only necessary to secure a gradual and easy variation from a given maximum to a given minimum speed, and in such cases the ellipse will serve every practical purpose.

Figure 5 shows a set of multilobes, derived by the method of figure 1 from the ellipse as the primitive curve. As the first derived curve, or unilobe, is an ellipse exactly like the primitive curve, and revolving like it on one focus, the two sets will be exactly alike, and all elliptic multilobes will roll together interchangeably, either in external or internal contact. When the eccentricity is great, the curves may interfere with each other, as shown by the figure, and practical internal contact be impossible.

Although the elliptic multilobes can be easily formed by the tentative method of figure 1, they are more accurately and easily formed by Holditch's method. As shown by figure 6, draw the primitive ellipse E, on the foci f and F, and with the minor radius $O\,b$. Then construct a series of concentric ellipses E_2, E_3, E_4, etc., having the same foci, and having minor radii equal to twice, three times, four times, etc., that of the primitive ellipse. From either focus draw a series of radiants, dividing half the ellipse into as many equal angles as may be convenient, ten in the example. Now, to construct any multilobe, such as the trilobe of figure 7, set off the angle $A\ F\ B$ equal to 180° divided by the number of lobes, 60° in the example, and divide this angle into the chosen number of smaller angles. On the radiants of figure 7 set off the distances cut off by the corresponding radiants of figure 6, and draw the trilobal curve through the points thus found.

Although the graphical method is very simple, it requires special skill for the construction of the several ellipses, and it is bet-

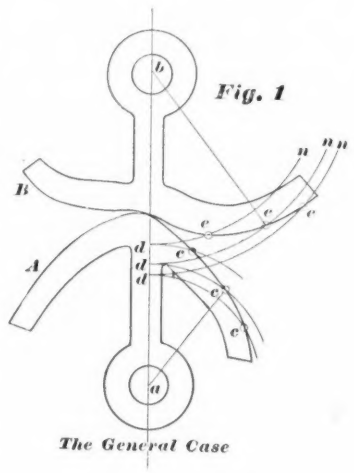


Fig. 1
The General Case

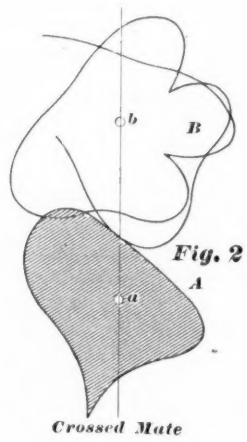


Fig. 2
Crossed Mate

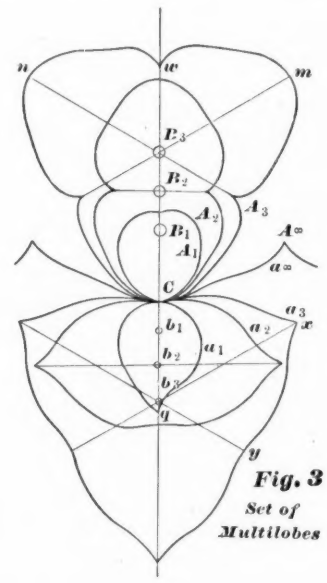


Fig. 3
Set of Multilobes

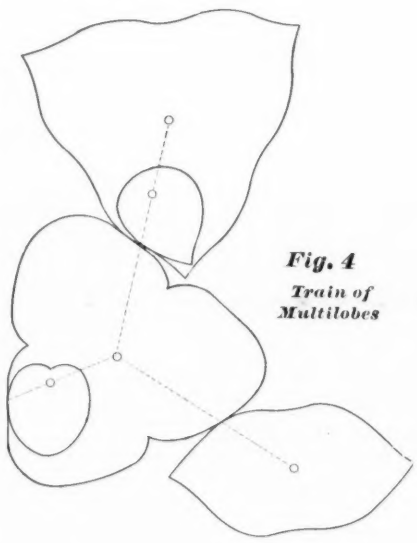


Fig. 4
Train of Multilobes

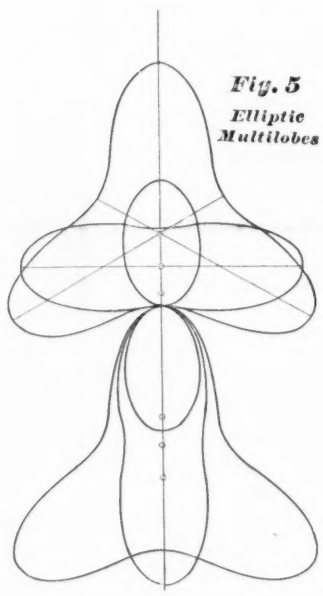


Fig. 5
Elliptic Multilobes

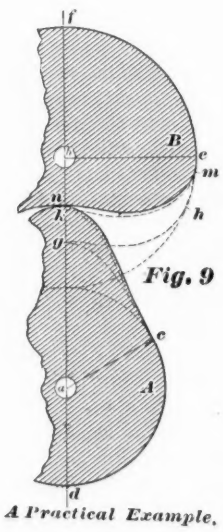


Fig. 9
A Practical Example.

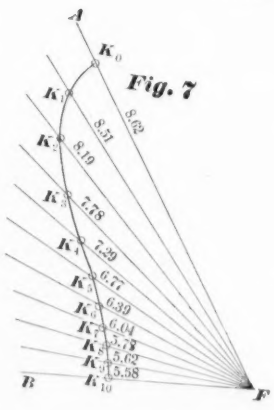


Fig. 7

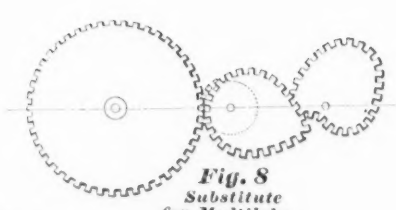


Fig. 8
Substitute for Multilobe

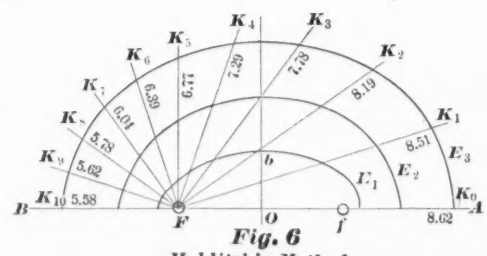


Fig. 6
Holditch's Method

Irregular Pitch Lines.

ter to find the radiants required by calculation from the following formula :

$$R = \frac{c \cos A\ F\ K + \sqrt{m^2\ b^2 + c^2}}{1 + \frac{c^2 \sin^2 A\ F\ K}{m^2\ b^2}},$$

in which R is the required radiant $F\ K$ for any angle $A\ F\ K$, figure 6, m is the number of lobes, b is the primitive minor radius $O\ b$, and c is the semi-focal distance $O\ F$.

Even when using the graphical method it is a simple matter to test the first and last radii by the formulæ

$$F\ K_0 = \sqrt{m^2\ b^2 + c^2} + c.$$

$$F\ K_{10} = \sqrt{m^2\ b^2 + c^2} - c.$$

For an example, calculate the radiants for a trilobe from a primitive ellipse having a semi-focal distance $c = 1.52''$, and a minor radius $b = 2.31''$. This gives the formula

$$R = \frac{1.52 \cos A\ F\ K + 7.10}{1 + .048 \sin^2\ A\ F\ K}$$

and the several trilobal radiants are :

$A\ F\ K_0$	$= 0°$	R_0	$= 8.62''$
$A\ F\ K_1$	$= 18°$	R_1	$= 8.51''$
$A\ F\ K_2$	$= 36°$	R_2	$= 8.19''$
$A\ F\ K_3$	$= 54°$	R_3	$= 7.78''$
$A\ F\ K_4$	$= 72°$	R_4	$= 7.29''$
$A\ F\ K_5$	$= 90°$	R_5	$= 6.77''$
$A\ F\ K_6$	$= 108°$	R_6	$= 6.39''$
$A\ F\ K_7$	$= 126°$	R_7	$= 6.04''$
$A\ F\ K_8$	$= 144°$	R_8	$= 5.78''$
$A\ F\ K_9$	$= 162°$	R_9	$= 5.62''$
$A\ F\ K_{10}$	$= 180°$	R_{10}	$= 5.58''$

SUBSTITUTE FOR THE MULTILOBE.

The multilobe is very difficult to make, and a practical, smooth running gear is the result of great patience and mechanical skill, but when the object is merely to get a series of variations between two given limits, it is not necessary to use it at all.

If a pair of unilobes are mounted, as in figure 8, and the driven shaft is geared in any given proportion to a third shaft, that third shaft will have the same general motion that it would have if it was driven by a multilobe. In the figure, the circular gears being proportioned three to one, give the third shaft the same motion as if driven directly by a trilobe.

In fact, the substitute is superior to the original in some respects. To get a variation between two given limits, the ellipse to drive a trilobe must be very much flatter than if the substitute is used.

We can, therefore, consider that the whole subject is practically reduced to the common ellipse, and, unless it is necessary to consider the rate of variation between given limits, nothing but a pair of elliptic unilobes is necessary. The elliptic gear wheel, being a considerable subject by itself, may be left for consideration at another time.

A PRACTICAL EXAMPLE.

To apply these principles to a practical case, let it be required to construct a quick-return motion, in the proportion of two to one. The half revolution of the driven gear is to be perfectly uniform, and the other half revolution is to be made in half the time. This gives the conditions, in figure 9, that $d\ c$, two-thirds of the driving gear, and $e\ f$, one-half of the driven gear, shall be circular, and with radii in the proportion of three to four.

It is required to construct a pair of irregular pitch lines by which the other one-third of the driving gear shall drive the other one-half of the driven gear. First, draw a curve $c\ g$ at random, but to be an easy curve that shall be tangent at c to the driving circle, and cross the line of centers $a\ b$ at a right angle. Constructing the mate by the process of figure 1, we get the curve $g\ h$, and $g\ h\ e$ is longer than $g\ c$. Second, draw the curve $c\ k$, and find its mate $k\ m$, which is still too short. Third, draw the curve $c\ n$, and construct its mate $n\ e$, which is exactly of the required length, and $c\ n$ and $n\ e$ are the pitch lines required.

A more difficult method would be to consider $c\ n$ to be an arc of an elliptic trilobe, and $n\ e$ that of the corresponding bilobe, and to find the dimensions of the primitive ellipse from which the required multilobes can be derived. This would be feasible, but not simple.

Fifteen-Inch Shaper.

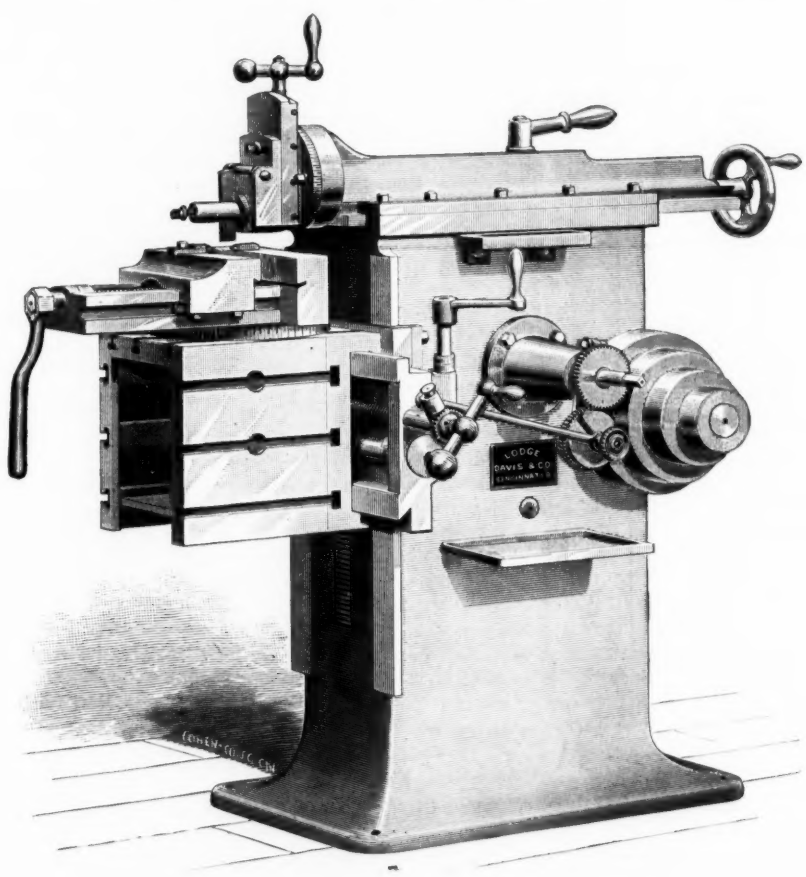
We illustrate herewith a design of shaper recently added to the list of tools built by Lodge, Davis & Co., of Cincinnati, Ohio.

The movement of the ram is given by a crank motion, and is so arranged as to admit of the length of stroke being varied at will while running.

The lengths of the ram and column slide are so proportioned that, when the former is out to the extreme of its travel, it has a bearing in the slide of 21¼ inches.

The vise swivels and is graduated, is 10 inches wide, 2 inches deep, and opens 8 inches. It can be transferred from the top of the table to either side.

It will be noticed the table is of the box form, which gives the advantages of great rigidity, and three surfaces upon which work may be fastened. It also forms a very convenient shelf for the keeping of tools, wrenches, etc., which are used about the machine. The table may be readily removed and work bolted direct to saddle, which has three T slots provided for the purpose. This is, of course, a very convenient feature when it is desired to work upon parts of large pieces which could not be fastened in the vise or upon the table ; such, for instance, as the legs of machines, etc.



FIFTEEN-INCH SHAPER.

The pulleys and gears are so proportioned as to give a high belt speed to secure ample driving power. The table has a vertical movement of 18 inches, a cross motion of 18 inches, and the tool block has 5 inches of movement in any direction. Sliding surfaces are scraped to a bearing. The cone has 4 steps for a 2-inch belt, the largest 10¾ inches diameter. Countershaft has tight and loose pulleys 12 inches diameter for 3-inch belt, and should run 240 revolutions per minute. Weight of machine, 1,500 lbs.

The Screw-Driver Question.

A Buffalo correspondent sends us a sketch of a long and a short screw-driver, in each instance the shank and handle being constrained to move around the axis without vibration. The object is to show that, under these conditions, the long screw-driver will have no advantage over the short one. We have never heard this disputed. If, under these conditions, the long screw-driver had an advantage, then it would be good policy to contrive to use a long line shaft, putting the power in at one end and taking it off at the other—a proposition that every mechanic would recognize as an absurdity. Nothing will come out of the screw-driver, in the way of starting the screw, that is not put into the handle. But if a lever, or handle, were put on the screw-driver, the shank being restrained from turning, then none of the twisting operation usually employed would be required to turn the screw. The question appears to us to be simply : With a long screw-driver is there an involuntary throwing the axis out of line, and to that extent making a lever? Those interested can try for themselves, without serious trouble, and so arrive at the best possible conclusion.

Another correspondent, who writes that he has followed a business for twenty years, in which he has constantly to use screw-drivers, fully believes in the advantages of the long screw-driver, and that this can be easily proved by trial. He writes : "I think the principle involved is that, with the long screw-driver, one is able to use the forearm at nearly a right angle to the blade, and the power that he can apply is limited only by the strength of the grip. With the short screw-driver the arm is, usually, nearly in line with the tool, and one can apply only what twisting force he may possess in the forearm.

"The wedge-shaped point on the screw-driver, that is usually condemned, is stronger than the concave, and will not slip out of the screw head if one takes a light hammer and upsets the point so there is a slight head on it, such as is on a carpenter's scraper."

Practical Drawing.

By J. G. A. Meyer.

FIFTY-SEVENTH PAPER.

483. In working drawings we have often to present or indicate the intersection of cylindrical surfaces, and also the intersections of cylindrical with straight surfaces. Sometimes it is necessary to show these intersections very accurately, and the methods for finding some of these intersections correctly have already been given in several previous problems. But frequently it is unnecessary to show these intersections very accurately, and consequently, in order to save labor, only an approximation of the true form of the line of intersection is shown. Take for instance an ordinary eye-bolt, such as is shown in Figs. 364, 365, page 6 ; in this case it would be a waste of time to work out correctly the intersection $a_2\ b_2\ a_4$ of the cylindrical surface I (that is, the surface of the body of the bolt) with the cylindrical surface H (the surface of the head of the bolt). For all practical purposes it is sufficient to show this intersection by an approximation of its true form, which can be accomplished in the following manner :

According to the remarks in our last problem we know that, in Fig. 365, the points a_2 and a_4, in which the elements $a_2\ e_4$ and $a_4\ e_2$ intersect the element $a_6\ a_8$, are points in the curve of intersection ; we also know that the points b or b_3 (Fig. 364), in which the elements $b\ d$ or $b_3\ d_3$ intersect the circumference $a\ f\ g$ are also points in the curve of intersection. Hence, through the point b or b_3 we simply draw a vertical line $b_3\ b_2$, cutttng the line $f_2\ d_2$ in the point b_2. Here, then, we have, in Fig. 365, three correct points, a_2, b_2, a_4, in the curve of intersection ; these points are then joined by an arc of a circle, and this arc will represent the intersection of the cylindrical surfaces. Although this arc contains three correct points, it is only an approximation to the true form of the intersection, but is sufficiently correct for all practical purposes, and can be very quickly drawn.

484. Figs. 366, 367 represent a connecting-rod for a marine beam engine ; cylinder 56 inches diameter and 12 feet stroke. The dimensions, here omitted, for the fork-end A are given in Figs. 356 and 358. The straps, brasses and keys for this end of the rod are precisely the same as those used for the front link shown in Figs. 353 and 354. If now these straps, keys, brasses, etc., had been shown in Figs. 366, 367, with all their dimensions, and the drawing made to a larger scale, say to 1½ or 3 inch scale, we would have a regular working drawing, such as would be required for putting together the different parts of the connecting-rod.

For the blacksmith shop, separate drawings should be made of all the wrought-iron pieces which help to make up the rod ; for instance, a separate drawing of the rod, without any straps, keys, bolts, brasses, etc.; a separate drawing of the struts B ; the braces $M\ M_2$; keys and gibs, and a drawing or list of bolts and set screws required. Also a separate drawing of the brasses for the pattern shop should be made. Detail drawings of this kind will, of course, increase the labor and expense of the drawing room ; but such a system will do more than repay itself in the end.

When a complete drawing of a connecting-rod is to be made, the center lines $C\ D$, $C_2\ D_2$ (Figs. 366, 367), also the center lines K, N, I, L, must first be drawn, and then the outline of the different pieces drawn around the center lines.

485. Since it is always desirable to make the drawing to as large a scale as possible, and since, in many drawing offices, the sizes of the sheets of paper are established, and are not allowed to be changed, the draftsman will often show a part of mechanism with a portion of it broken off, as we have done above the center line I, in Figs. 366, 367. Indeed, for a regular working drawing we should also have broken off the portion of the rod and braces from $e\ f\ e_2$ to $g\ h\ g$, so as to gain a greater available space on the paper for showing the ends of the rod, with their straps and keys, etc., to as large a scale as possible, enabling us to show distinctly all the small arcs, curves, straight lines, etc., which form the outline, and also enabling us to give, without creating confusion on the drawing, all the dimensions in large figures, which can easily be seen and read by the workman.

Directions.—On one of the small sheets make a complete drawing of the connecting-rod, to as large a scale as the paper will permit. Two views, as shown in our illustration, will be sufficient. On the fork-end show the straps, brasses and keys ; the form and dimensions of these are given in Figs. 353, 354 ; the dimensions of the fork-end are given in Figs. 356, 358. Above the center line I (Fig. 365), a portion of the rod should be broken off, so as to gain more room for showing the straps, etc. Below the center line I nothing should be broken off the rod, as this will give the student better practice, and also enable him to obtain the angle of the portions of the braces shown above the center line I. Work out all intersections of the cylindrical surfaces, and also the inter-

sections of cylindrical with straight surfaces. It will be good practice to work out these intersections to a larger scale in pencil on a brown sheet of paper, and then copy them on the regular small sheet. There should not be any difficulty in working out these intersections, as the methods for finding all these different intersections have been explained in previous problems. On the same sheet show separate views of the struts, keys, gibs, bolts, braces, and the rod itself, with dimensions suitable for sending in a blacksmith shop.

PROBLEM 71.

486. *Intersections of cylindrical surfaces.*

Fig. 368.—Let $a\ a_3\ b\ b_3$ represent a hollow cylinder, $d\ b$ or $d_3\ b_3$ being the thickness of the material; also let $e\ e_3\ f\ f_3$ represent a smaller cylinder, which is passed through the hollow one. The axes of both cylinders are in the same plane, and this plane is parallel to the vertical plane of projection. It is required to find the intersections of the cylindrical surfaces.

On the left-hand side, in Fig. 368, we have shown the intersection of the small cylinder with the outer surface of the hollow cylinder; and on the right-hand side of the same figure we have shown a section of the hollow cylinder; on this side a portion of the small cylinder is broken off, so that both the intersection of the inner and outer surfaces of the hollow cylinder with the surface of the small cylinder, made by passing the latter through the former, can be seen. We will first find the intersection of the small cylinder with the inner surface of the hollow one.

To find this intersection we need two other views of the same cylinders besides the projection shown in Fig. 368; but, as stated in our last paper, it is not necessary to show, in these two extra views, the whole outline of the cylinders. Thus, instead of showing, in Fig. 368*a*, a complete end view of the small cylinder, and also the outline of the hollow cylinder, it is only necessary to show one-half of the end of the small cylinder, and this half is represented by the semi-circle $f_5\ i_5\ f_7$. In drawing this semi-circle great care must be taken to have its center x on the center line $g\ i_5$; that is to say, on the prolongation of the axis $g\ h$ of the small cylinder; and, of course, the diameter of this semi-circle must be equal to the diameter of the small cylinder. Since our purpose is only to find the curves of intersection in Fig. 368, an outline of the large cylinder, in Fig. 368*a*, is not necessary, because we have no use for it. In the horizontal projection, Fig. 369, we only need to show one-half of the hollow, and one-half of the small cylinder; for the other half we have no use, as the outlines of these cylinders are perfectly symmetrical on each side of the center line $e_3\ f_3$. In this figure the rectangle $e_3\ f_3\ g_3\ h_3$ is a projection of one-half the small cylinder; the semi-circle $a_2\ b_2\ c_2$ is a projection of one-half of the outer surface, and the semi-circle $d_2\ d_4\ d_6$ a projection of one-half the inner surface of the hollow cylinder.

Now to find the intersection of the small cylinder with the inner surface of the hollow cylinder, we consider this inner surface to represent a bounding surface of a geometrical solid (see Art. 17); or, practically speaking, we may consider the inner surface of the hollow cylinder to represent the bounding surface of a solid cylinder, and pay no attention to anything that is outside of this surface. We thus reduce the problem before us to Problem 70, and consequently the method for finding the intersection of the small cylinder with the inner surface of the hollow cylinder is precisely the same as the method adopted for finding the intersection of the outer surfaces of two cylinders such as have been shown in Fig. 361. Hence only a very brief explanation for finding the intersection in the present problem will be given.

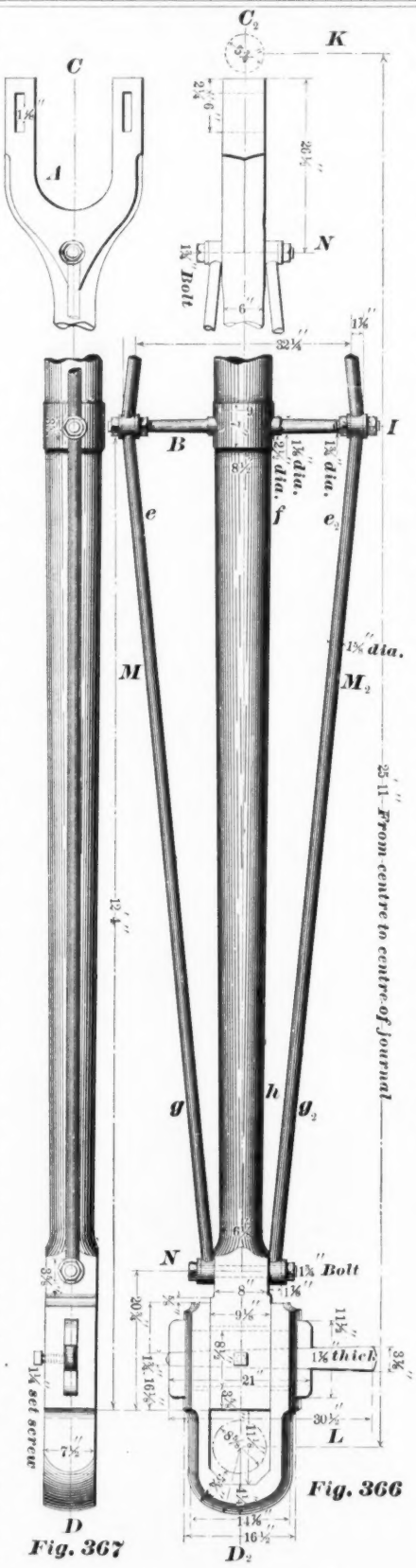
In Fig. 369 we see that the element $g_3\ h_3$ intersects the semi-circumference $d_2\ d_4\ d_6$ in the point l_5. Divide the arc $l_5\ d_2$ into any number of equal parts, say four; and through the points of division $l_2\ l_3\ l_4$, draw the horizontal lines $g_5\ h_5$, $g_6\ h_6$, and $g_4\ h_4$; also through the point l_5 and the same points of division draw vertical lines such as $l_5\ 5$, $l_4\ 4$, $l_2\ 3$, etc. From the center x, in Fig. 368*a*, lay off on the line $x\ i_5$ a number of points, as x_2, x_3, x_4; the distance between the points x and x_2 must be equal to that between e_2 and g_5 in Fig. 369; the distance between x and x_3 must be equal to $e_3\ g_6$; and lastly, the distance between x and x_4 must be equal to $e_3\ g_4$; also, if the different views are correctly drawn $e_3\ g_2$ will be equal to $x\ i_5$. Through the points x_2, x_3, x_4 draw vertical lines cutting the semi-circumference $f_5\ i_5\ f_7$ in the points $i_2\ i_8$, $i_3\ i_7$, and $i_4\ i_6$, respectively. Through these points draw horizontal lines, such as $i_2\ a_7$, $i_3\ a_9$, etc.

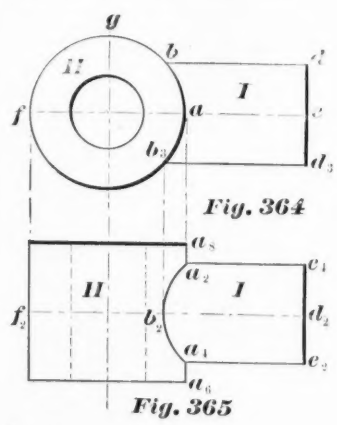
The element $f\ a_5$ of the small cylinder cuts the line $d\ d_3$ (which is an element of the inner surface of the hollow cylinder) in the point 1; this will be one point in the curve of intersection; the horizontal line $i_2\ a_7$ cuts the vertical line $l_2\ 2$ in the point 2; this will be another point in the curve of intersection; and the horizontal lines $i_3\ a_9$, $i_4\ a_{11}$, $i_5\ a_{12}$, will cut the vertical lines $l_3\ 3$, $l_4\ 4$, $l_5\ 5$, in the points 3, 4, 5 respectively; these points will also be points in the curve of intersection. Joining these points by a curved line we obtain the intersection of the small cylinder with the inner surface of the hollow cylinder above the center line $g\ i_5$. In a manner precisely similar to the foregoing we obtain the points 6, 7, 8 and 9; a curved line drawn through these points will be the intersection of the cylindrical surfaces below the center line $g\ i_5$, and will be equal in every respect to the curve drawn from point 1 to point 5.

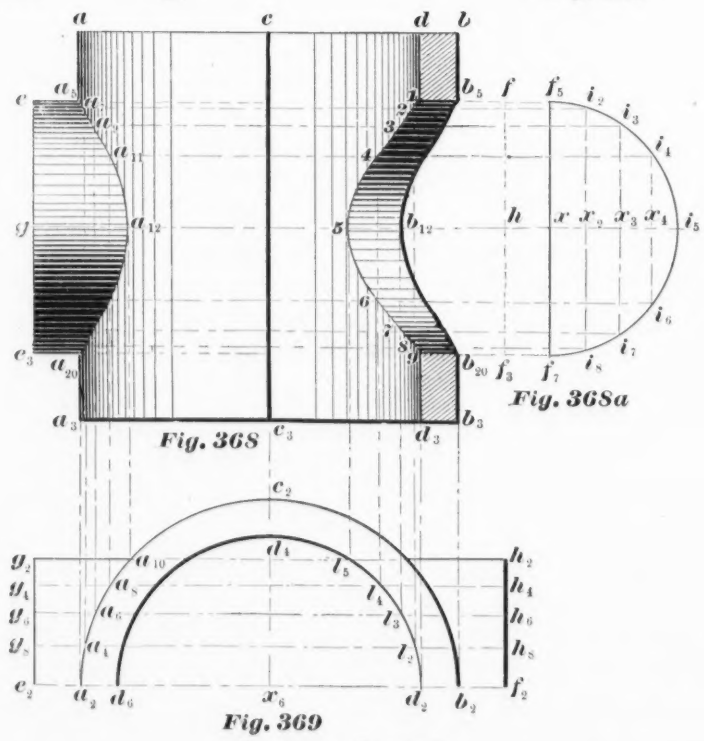
The curves $a_5\ a_{12}\ a_{20}$ and $b_5\ b_{12}\ b_{20}$ represent the intersections of the small cylinder with the outer surface of the hollow cylinder; these two curves are exactly alike. The manner of finding these curves has been explained in our last problem, and needs no other explanation excepting the following remarks, which will indicate how labor can be saved in particular cases, such as given in the problem before us. In order to find the curve of intersection $a_5\ a_{12}\ a_{20}$ we need not divide the arc $a_2\ a_{10}$, in Fig. 369, into equal parts, but may use the points a_4, a_6, a_8, a_{10}, in which the horizontal lines $g_2\ h_2$, $g_4\ h_4$, etc., intersect the semi-circumference $a_2\ b_2\ c_2$. Through these points draw vertical lines. The vertical line through the point a_4 will cut the horizontal line $i_2\ a_7$ in the point a_7; the vertical line through a_6 will cut the horizontal line $i_3\ a_9$ in the point a_9; the vertical line through the point a_8 will cut the horizontal line $i_4\ a_{11}$ in the point a_{11}; and lastly, the vertical line through a_{10} will cut the line $i_5\ a_{12}$ in the point a_{12}; joining the points $a_5\ a_7\ a_9\ a_{11}\ a_{12}$ we obtain a curve which will be the intersection of the two cylindrical surfaces above the center line $g\ i_5$. In a similar manner we obtain the curve of intersection below the center line $g\ i_5$.

It may be remarked here that the distances between the points a_4, a_6, a_8, a_{10}, will not be equal to each other, but this makes no difference. If, on the other hand, we divide the $a_2\ a_{10}$ into equal parts, and thus establish other points of division in place of the points $a_4\ a_6$, $a_8\ a_{10}$, we would also be compelled to establish other points in place of the points x_2, x_3, $_4x$, in Fig. 368*a*; and thus giving us considerable extra work, as well as a confusion of lines, which should always be avoided.

Directions.—In the space marked Prob. 71 draw a hollow cylinder 7½ inches outside diameter, 6 inches inside diameter, and 8 inches long. Through the center of this cylinder draw a smaller one 5 inches diameter and 9½ inches long. The axes of these cylinders must be at right angles to each other, and lie in the same plane, as shown in our illustration. Find the intersections of the cylindrical surfaces. Use a three-inch scale.







LETTERS FROM PRACTICAL MEN.

The Use of the Slide Rule.

Editor American Machinist:

I have seen Mr. Redfield's article on "Draftsman's Kinks," which appeared in your paper for July 28, and desire to offer a word for my pet hobby—the slide rule—as applied to such work. Users of the slide rule are invariably enthusiasts—others say cranks—on the subject, and one of the few questions which they ask in vain is why its use is not universal.

The stock objections to it are, that it is not sufficiently accurate; that it is difficult to learn, and that, after learning, it requires constant use to keep in practice.

To test the first objection, I have just determined with it the circumferences of a large number of circles, and compared the results with the tables in the pocket books. The greatest single error was less than one part in four hundred. Now there are many people in this world who will be shocked at the idea of admitting an error of that magnitude into their calculations; but every experienced draftsman knows (unless his work is very exceptional) that in ninety per cent. of his calculations an error of that size is of no consequence whatever. In fact, the attempt to work to even that degree of accuracy in most work is simple pedantry—refined hair splitting—and not engineering.

As for the second objection, I will engage to teach anyone who understands logarithms, all there is to know about the principle of the instrument in ten minutes. If the learner does not understand logarithms it will take longer, but not long enough to offer any objection worth mentioning. The chief difficulty in learning to use the slide rule is in *reading* it. In the rules to which we are accustomed, every prime division (inch) is of the same length as every other, and all are divided alike into eighths or sixteenths. In the slide rule, however, the prime divisions are of various lengths, and while the short ones are divided into but ten subdivisions, the longest are divided into fifty. This arrangement is puzzling to the eye, and practice is necessary to become accustomed to it; but certainly no one who is accustomed to make calculations at all, will find it a serious matter to master it.

The third objection, if true, would not be valid, for once learned the instrument will be kept in constant use. It is not considered an objection to the multiplication table that practice is necessary to retain expertness in its use. In point of fact, however, the rule is very easily remembered, owing to its great simplicity.

I have great admiration for graphical methods for certain classes of work, but for

most arithmetical problems of the class illustrated, the slide rule will give its answer before the graphical construction is fairly commenced. Moreover, at best the graphical constructions are burdensome to remember. It is easy enough to retain a few, but the burden increases rapidly as the number learned multiply. Each one stands by itself as an isolated fact, and, having no relation to one another, they must be remembered as isolated facts. All the operations of the slide rule, however, depend upon the same principle, and hence its burden on the memory is trifling.

Referring now to Mr. Redfield's arithmetical problems, the slide rule will give the square, and the square root of the first problem, but it will not perform the addition, so that using a pencil for the addition, the slide rule method would probably consume as much time as the graphic process. The slide rule will solve the second problem, however, before Mr. Redfield can get his first line drawn.

Following is a list of the principal things which the slide rule does:

Multiply and divide by whole numbers.

Multiply and divide by fractions.

Solve problems in proportion (direct or inverse).

Reduce common fractions of any denomination to decimals, and *vice versa*.

Reduce common or decimal fractions to the nearest 32d or 64th.

Find the circumferences of circles, the diagonals of squares, and all similar problems involving multiplying by a ratio.

Find squares and square roots.

Find cubes and cube roots.

Find fourth powers and fourth roots.

Find the square or the square root of fractions (the entire problem involving but one operation).

Find the areas of circles and all similar problems where one quantity varies as the square or the square root of another.

Find the mean proportional between any two numbers (the entire problem at one operation again).

Find logarithms.

Find trigonometric sizes.

Find trigonometric tangents.

Now I think it will be admitted that the above list comprises a large part of the computations which draftsmen have occasion to make. Nearly all are solved by simply setting the rule to the numbers involved and reading the result at once. In many cases (circumferences and areas of circles, for example,) once setting the rule gives all possible answers to similar questions; in short, the rule becomes a table without limit as to length, from which the answer can be read off before the place can be found in the pocket book.

Frederic A. Halsey.

The Delhi Column.

Editor American Machinist:

In answer to query 259 in issue of May 19th, and to the reply in issue of June 9th, I would say that the following are some of the dimensions of the "iron column at Delhi," as copied from "Text Book of the Materials of Construction," by Doctor R. H. Thurston:

Height above ground.....	....22 ft.
As excavated below ground thus far.....	.....26 ft.
Estimated length not less than.....	.....60 ft.
Lower diameter.....	.....16.4 in.
Upper.....	.....12.5 in.

It contains about 80 cubic feet of metal, and weighs upwards of 17 tons.

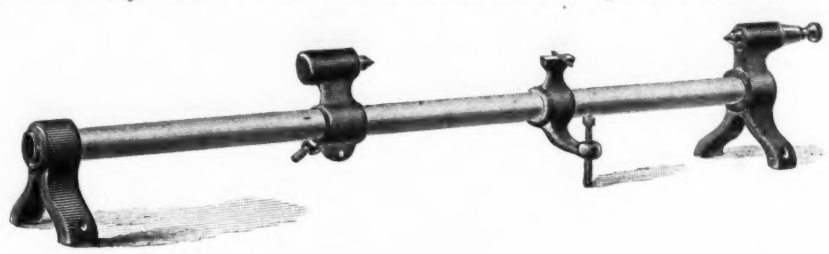
The date of this column (which seems to be made up of a large number of blooms of 60 or 80 pounds weight, each welded together at the forge,) is not well ascertained, but is supposed to be not far from 900 B. C. Dr. Percy has analyzed and tested a piece of this iron column, of which a cast has been placed in the South Kensington Museum, London, and has pronounced it to be soft wrought-iron.

Harry Hutton.

Ithaca, N. Y.

Bench Centers.

The engraving represents a bench center, made by John Birkenhead, Mansfield, Mass. A semi-circular groove underneath the tube, and a spline in the movable head, keeps the latter in line with the head center. This head is split, and clamped in position by means of a T-headed screw. A spring in the fixed head behind provides for adjustment for small variations in length. The marking rest slides freely, and the marker is brought up to the work by means of a thumb-screw, which abuts against the bench.



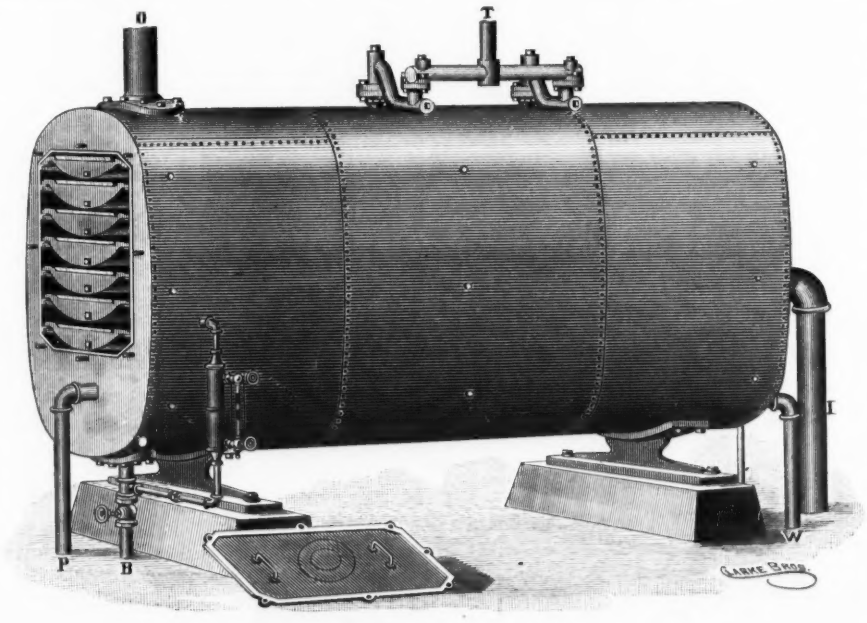
Bench Centers.

The Hoppes Exhaust Steam Feed-Water Heater.

The engraving herewith represents a feed-water heater, brought out by the Hoppes Mfg. Co., Springfield, Ohio. It is, as will be seen, made elliptical in form, so as to provide for the use of a larger number of the troughs, or settling pans, shown at the end.

The water is admitted into the top at *T*, and flows downward over both sides of the troughs, following the bottom or underside of each trough to the center before dropping into the next below, and so on over each successive trough until it reaches the chamber at the bottom, from which it is pumped from pipe *P* into the purifier, or direct to the boiler, as the case may be, the dirt remaining in the troughs, from which it is removed from time to time.

The exhaust enters the heater at *I*, and passing between the troughs to the front end, escapes at *O*. It will be seen that the exhaust steam, in passing through the heater, comes in *direct contact* with the water as it flows in a thin sheet under the bottoms of the troughs, thereby affording excellent facilities for heating. At the back end of the heater is a separate chamber, into which the exhaust first enters, and which is arranged to catch the oil and grease from the engine and discharge them through the small pipe shown in the cut, thereby preventing them from entering the heater.



Exhaust Steam Feed-Water Heater.

These heaters are provided with *hard sheet steel* troughs, which are light and readily cleaned. They also have large lime-catching surface. In use they are opened at intervals, corresponding somewhat to the quality of water used, when the scale formed in the pans is easily removed, and the heater made clean for further use.

English and American Locomotive Practice.

By W. H. Booth.

THIRD PAPER.

In general external appearance there is little difference between an American and an English locomotive boiler. But there are a number of differences in detail. The first we notice is the longer fire-box of the American engine, which is due partly to its smaller width, which in turn, as already explained, is due to the influence of the bar frame. Another cause of greater length is of course the poorer steaming qualities of the American coal. The immediate result of the altered shape of ~~fire~~-box is that, in place of the roof bar stays being disposed longitudinally, as in England, these are in the American engine placed transversely upon the fire-box crown, otherwise the staying, including the numerous stud stays, presents little difference. The material of the fire-box, however, is different. English practice almost exclusively favors copper for fire-boxes, whilst steel is the almost universal material in America. The users of copper consider it more reliable than steel, and less liable to fracture, whilst it is a better conductor of heat, and so less liable to burn. On the other hand, American engineers urge that steel can be used thinner than copper, and that copper has the disadvantage of a higher co-efficient of expansion than iron or steel, and so causes great strains by the difference in length between the box hot or cold, and the outer shell. They also urge that, as steam pressures become yearly higher, the temperature is getting too close to the limit beyond which the strength of copper rapidly diminishes, and they further state that steel is perfectly reliable, and point to the great number of fire-boxes of this material in evidence.

The whole subject is one surrounded with difficulties, and it does not appear that anything definite can be said in entire favor of either material. The same also may be said of the tubes, which, while usually of brass in English practice, are of iron or steel in America.

The brass tubes are certainly the most efficient, but iron is so very much less costly that it has become almost universally used in America. Where hard coal is used it may be stated that copper and brass are too soft to withstand the wear and tear of so hard a material, and probably this has had some effect in determining the use of iron or steel in preference to the softer copper or brass.

Generally the boiler of an American locomotive has a barrel of large diameter to an English eye. Large boilers are not merely required because of the inferior quality of the coal, but because the American engine requires more steam than an English engine. The reason for this is twofold. First, an English engine is probably a more efficient machine considered as a heat engine, and secondly, the American engine is, as a rule, called on to draw a heavier train than customary in England. To do this with equal cylinders and steam pressure it must have a greater tractive force and probably a later cut-off, and so is made with small wheels, and therefore for each mile traveled makes a greater number of revolutions and draws more cylinders full of steam from the boiler, and, as a rule, it may be said that the speed of trains in America is, for the diameters of wheels employed, higher than English speeds. Generally speaking, English boilers are more solidly built than American, and in the best practice both longitudinal and ring seams are made with the butt-joint double stripped. The barrel is therefore parallel, in place of, as so usual in America, being telescopic. Such differences as these, however, are not differences of principle, and merely represent the common practice in America of allowing working pressures in boilers to exceed by somewhere about twenty per cent. what would be allowed in England. The most noticeable difference in the American boiler is the extended smoke-box. Its rapid and general adoption appears to show that it has proved effectual as a spark preventer, as theory would teach us should be the case. The extended box has as yet obtained no foothold in England, though it has been constructed there for exportation to tropical and other countries. In other details of the boiler, the dome is less common in England than it formerly was, and the boiler itself is usually straight-backed, whilst the regulator or throttle valve is of the slide variety, and the double-seated valve of American practice is never seen. The English throttle opens by means of a lever moving transversely to the engine, and in this respect is better than the American method, where the lever moves in a direction parallel to the motion of the locomotive; and frequent accidents have occurred from the accidental opening of the easily moved equilibrated throttle from some accidental slight bump, the inertia of the lever being sufficient to cause a slight opening of the valve and start the machine away. It is also far more likely that a slide valve should remain steam-tight than a double-seat valve, but slide valves have the disadvantage of requiring quite a heavy pull to move them, and to overcome this difficulty a small supplementary valve is usually added, which, by letting steam into the dry pipe, balances the pressure on the back of the main valve, which can then be be moved readily.

One of the most noticeable differences between American and English practice is in the diameter of the dry pipe. For engines of equal size we find that where a 4½ inch pipe is enough in England, the American engine has an 8-inch pipe. It is true that the smallness of wheels may at equal speeds call for a dry pipe some fifty per cent. larger, but for one nearly four times the English area, there is no call. As English engines get as close to boiler pressure on their pistons as do American, it seems that the diameters of American dry pipes are unnecessarily large—a fault in the right direction, truly.

In Carlisle, England, tall factory chimneys are being utilized as sewer ventilators with good results, twenty-nine now being used. The velocity of the rising air has been measured by Surveyor Mekie, and it is found to be 1,202 feet a minute in ordinary weather. The owners of the factories make no objection to this use of their chimneys, and the practice seems to meet with general approval. This suggests a plan that probably might be profitably employed in many cities in this country. With chimneys of ample proportions there would seem to be no serious trouble in using them to some extent as ventilators.

AMERICAN MACHINIST

To prevent delays all Communications should be addressed to the Company.

PUBLISHED WEEKLY
BY
American Machinist Publishing Co.
96 Fulton Street, New York.

Horace B. Miller, Pres't and Bus. Manager.
Lycurgus B. Moore, Treas. and Sec'y.

F. F. Hemenway, Editor and Mech. Engineer.
J. G. A. Meyer, } Associates.
Fred J. Miller, }

Special Announcements.

☞ *Positively we will neither publish anything in our reading columns for pay or in consideration of advertising patronage. Those who wish to recommend their wares to our readers can do so as fully as they choose in our advertising columns, but our editorial opinions are not for sale. We give no premiums to secure either subscribers or advertisers.*

☞ *Every correspondent, in order to insure attention, should give his full name and address, not for publication, but as a guarantee of good faith.*

☞ *We are not engaged in procuring patent rights, or in selling machinery, nor have we any pet scheme to advance, or hobby to ride.*

☞ *We invite correspondence from practical machinists, engineers, inventors, draftsmen, and all those specially interested in the occupations we represent, on subjects pertaining to machinery.*

☞ *Subscribers can have the mailing address of their paper changed as often as they desire. Send both old and new addresses. Those who fail to receive their papers promptly will please notify us at once.*

Subscription.

$2.50 a year in advance, postage prepaid in the United States, Canada and Mexico.
$3.50 a year to Other Countries, postage prepaid.

Advertising.

Transient, 35c. per line, each insertion.
"Business Specials," 50c. a line.

The American News Company,
Publishers' Agents, New York.
The International News Company,
11 Bouverie Street, Fleet Street, London, Eng., will receive subscriptions for the American Machinist, at 14/7 per annum, postage paid.

DEALERS SUPPLIED BY
The Albany News Company, Albany, N. Y.
The American News Company, New York, N. Y.
The Baltimore News Company, Baltimore, Md.
The Brooklyn News Company, Brooklyn, N. Y.
The Central News Company, Philadelphia, Pa.
The Cincinnati News Company, Cincinnati, Ohio.
The Cleveland News Company, Cleveland, Ohio.
The Colorado News Company, Denver, Colorado.
The Detroit News Company, Detroit, Mich.
The International News Company, New York, N. Y.
The Minnesota News Company, St. Paul, Minn.
The Montreal News Company, Montreal, Canada.
The National News Company, New York, N. Y.
The Newark News Company, Newark, N. J.
The New England News Company, Boston, Mass.
The New Orleans News Company, New Orleans, La.
The New York News Company, New York, N. Y.
The Northern News Company, Troy, N. Y.
The Omaha News Company, Omaha, Neb.
The Pittsburgh News Company, Pittsburgh, Pa.
The Rhode Island News Company, Providence, R.I.
The San Francisco News Co., San Francisco, Cal.
The South West News Company, Kansas City, Mo.
The St. Louis News Company, St. Louis, Mo.
The Toronto News Co., Toronto, Ontario, Canada.
The Toronto News Co., Clifton, Ontario, Canada.
The Union News Company, New York, N. Y.
The Washington News Company, Washington, D. C.
The Western News Company, Chicago, Ill.
The Williamsburgh News Co., Brooklyn, E. D., N. Y

NEW YORK, AUGUST 25, 1888.

CONTENTS.

	PAGE
New Boring and Turning Mill	1
Force in the Steam Engine, and its Relation to Smooth Running	1, 2
Shop Notes. By Jarno. No. 10	2
Globe Valve Patterns. By W. F. Barrows. First Paper	2, 3
Swing Cut-Off Saw	3
Irregular Pitch Lines. By Geo. B. Grant	4, 5
Fifteen-Inch Shaper	5
The Screw-Driver Question	5
Practical Drawing. By J. G. A. Meyer. Fifty-seventh Paper	5, 6
Letters from Practical Men: The Use of the Slide Rule. By Frederic A. Halsey—The Delhi Column. By Harry Hutton	6, 7
Bench Centers	7
The Hoppes Exhaust Steam Feed-Water Heater	7
English and American Locomotive Practice. By W. H. Booth. Third Paper	7
Rating Boilers by Heating Surface	8
Jute Machinery and the Pending Tariff Bill	8
Sectional Boilers in the Navy	8
Literary Notes	8
Questions and Answers	8, 9
Manufactures	9
Machinists' Supplies and Iron	10

Rating Boilers by Heating Surface.

Conscientious boiler makers complain, and with a good deal of reason, that the custom of rating boilers by the amount of heating surface operates against them. It is an easy matter, for example, to increase the heating surface of the ordinary tubular boiler by adding tubes beyond the requirements of the case, and this is often done, notwithstanding the use of such extra tubes does not increase the steaming capacity, and is a positive disadvantage in other respects. But these extra tubes help to increase the "horse power," measured by the heating surface, and that helps sell the boiler to many users.

It would be a good thing if, in the matter of spacing tubes, there were uniformity of practice, determined by experiment and observation, and sanctioned by the best boiler makers in the country. Or, if the exact manner of spacing could not be agreed upon, the maximum number of tubes of different sizes in a given shell could be. This would remedy an evil against which honest boiler makers have to contend, for it would limit the possible heating surface for which a tubular boiler of given diameter and length could be sold.

It is useless to expect the ordinary purchaser to settle this for himself. He depends upon what he is told, and anything beyond some simple, authoritative statement would be thrown away upon him. But the statement that he could get only so much effective heating surface from a shell of given dimensions, no matter how many tubes it might contain, would be so simple that he could understand it.

A good many evils have grown up in the practice of both making and rating boilers, due to competition and love of temporary gain. And these practices operate in favor of the unscrupulous builder, and they have a direct tendency to drive the honest builder out of the business. There are now none too many of these left in the trade, and they ought to take measures to protect themselves.

Jute Machinery and the Pending Tariff Bill.

There is a proposition before Congress to put jute machinery on the free list, and the statement has been conspicuously made in Congress, and in the newspapers, that there is no machinery made in this country for the conversion of jute, or jute butts, into cotton bagging. The statement is untrue. Joseph C. Todd, of Paterson, N. J., while also a manufacturer of such bagging, builds a full line of the machinery required for this purpose, for the general market, as is well known to most bagging manufacturers during many years past. We are also informed that Joseph Nussey & Co., of the same city, build a similar class of machinery.

When Congress legislates to put jute machinery on a radically different basis from that prescribed for other machinery, and particularly for the machinery, tools and supplies involved in its construction, it should at least do so upon correct information. And more especially so when the immediate beneficiaries of its action would be the bagging manufacturers, who, as we understand it, are just now organizing themselves into a trust or combination.

Sectional Boilers in the Navy.

The Navy Department, in calling for plans and estimates for tubulous, sectional or coil boilers, with a view, as stated, of considering the use of some of these types in the new war vessels, shows refreshing evidence of the waking up of Government officials to the progress in boiler making of the past twenty years. Boilers of these types are successfully used for other purposes, especially where strength, lightness and small space occupied are important objects. Some of them are also claimed to be very economical in the use of fuel. These are all important features in the instance of naval vessels. True, it does not follow that the use of boilers possessing all these qualifications is advisable in such vessels; this is exactly what is to be determined, and in offering to provide for tests of such boilers as the manufacturers may submit, the Naval Department is putting itself in the way of finding out.

We have no reason to doubt that the builders of the kind of boilers named will meet the department half way in the matter of tests, and if these tests are carefully made, as they no doubt will be, something of general practical value in relation to steam making may be learned.

In France a very practical use of photography has recently been made. Several persons were imprisoned by the caving in of a wall. A hole was bored, and down this a tube with a camera was slid. The photograph showed the faces of some of the dead men, and demonstrated the uselessness of efforts at rescue.

There are at the present time Congressional and State investigations of "trusts." What it is supposed these investigations will amount to is hard to be seen. Nothing short of a modest though not necessarily violent revolution will shake off the grip of the various trusts in this country. It is better to let them go on than to attempt to use abortive methods to check them.

In sinking a drive well for water, near Brigham City, Utah, natural gas was struck in such quantity as to make things exceedingly lively. The fortunate or unfortunate explorer of the earth's interior was like the man with the elephant—he didn't know what to do with it, and was obliged to hustle lively to save his house from the mud and dirt thrown up by the force of the escaping gas.

Literary Notes.

THE CIVIL ENGINEER'S POCKET-BOOK, OF Mensuration, Trigonometry, Surveying, Hydraulics, Hydrostatics, Instruments and their Adjustments, Strength of Materials, Masonry, Principles of Wooden and Iron Roof and Bridge Trusses, Stone Bridges and Culverts, Trestles, Pillars, Suspension Bridges, Dams, Railroads, Turnouts, Turning-Platforms, Water Stations, Cost of Earthwork, Foundations, Retaining Walls, etc., etc., etc. In addition to which the elucidation of certain important Principles of Construction is made in a more simple manner than heretofore. By John C. Trautwine, C. E., author of "A Method of Calculating the Contents of Excavations and Embankments" "The Field Practice of Laying Out Circular Curves for Railroads," etc. Copiously Illustrated. Thirteenth edition, thirty-second thousand. Revised by John C. Trautwine, Jr., C. E. New York: John Wiley & Sons, 15 Astor Place.

It seems unnecessary to commend a book that has attained the standing this one has. For years it has been considered standard amongst practical men—a position it has attained by virtue of its clearness and conciseness. In this respect there is no work of the kind published in the English language that can compare with it. It was the pride of the author, himself an eminent civil engineer, that he had made this work plain enough to be comprehended by the ordinary reader; and, strange enough, the only attacks ever made on it were upon the grounds that, substantially, it placed too much technical information in the hands of unprofessional men. It is needless to say that it has withstood such attacks without injury.

Since its first appearance the work has been revised and enlarged by the author, and since his death, by John C. Trautwine, Jr. The revisions in the present editions are not numerous, but they are good to the extent they go. The additions, mainly in previous editions, have brought the book up to 866 closely printed pages.

Although the work is more especially in the line of civil engineering, it is almost as valuable to the mechanical engineer, amongst whose books it is sure to be found.

The price of the book is five dollars.

The Kansas City *Commercial* is out with a special manufacturers' edition. It is gorgeous in colors, and booms Kansas City as a manufacturing and trade center.

Questions and Answers.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly, and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.

(388) C. N., Marshalltown, Iowa, asks: Will putting salt in a ladle of melted iron make the iron cleaner or dirtier? *A.*—It will probably have little or no effect, one way or the other.

(389) J. V. N., Albany, N. Y., asks: Is there any way to prevent the soot from soft coal gathering in boiler tubes? The tubes must be cleaned every day. *A.*—We know of no way. Tubes should be cleaned every day when soft coal is burned.

(390) J. H., Cleveland, Ohio, asks: 1. Will an injector force water in a boiler completely filled with cold water, and the safety valve set at 100 lbs.? *A.*—Yes. 2. Does the publishing of an invention previous to application for a patent, prevent the inventor from obtaining one? *A.*—Not necessarily, but it is better not to publish it; it may make it common property.

(391) A. B., Philadelphia, Pa., writes: In J. Weisbach's Theoretical Mechanics, on page 42 (Fourth American Edition), sixth line from below, I find the abbreviation E. G. On page 464, thirteenth line from above, I find the same abbreviation. I have never seen these before. Although they seem to be of no grave importance, my curiosity is excited. What do these abbreviations mean? *A.*—The abbreviation E. G. means, "for example." Thus, on page 464, thirteenth line, Weisbach says: "Others, as, E. G., Morin, made use of a cathometer, etc." This sentence reads: Others, as, for example, Morin, made us of the cathometer, etc. You will find the meaning of these abbreviations in any first-class dictionary.

(392) J. M. T., Toronto, Canada, writes: Please give me the best method or rules you know of for calculating the exact superficial measurement of a radiator section or loop. I have a radiator made in sections, each section is estimated to contain 8 square feet of heating surface, which we get by measuring the surface of section. My friends say the correct way to measure is to place the casting in a box, then fill up the box with water, lift out the casting and measure the displacement of water. Now can this measurement be converted into superficial measure—if so, how can it be done? *A.*—By measuring the displacement of water you obtain the cubical contents in cubic inches or cubic feet, or in whatever unit of measurement you may adopt. This measurement cannot be converted into superficial measurement. The superficial measurement you can only obtain by finding the number of square inches in the outer surface of the castings, by rules given in any good book treating on mensuration. If you had given us the shape of the casting we could have pointed out the rule to use.

(393) T. C., Ottumwa, Iowa, writes: I placed a pressure gauge on the wind-box of a cupola in the Ottumwa Iron Works. When we started the fan the water fell 6 inches on one side and raised 6 inches on the other. The foreman claims that there is only a pressure due to the 6-inch rise, and I claim that there is a pressure due to the 12-inch rise. Would like to know who is right. Also state how to obtain the pressure in ounces. *A.*—The difference between the water level on one side and the water level on the other side of the gauge is 12 inches, and therefore there must be a pressure which supports a column 12 inches high, hence your gauge indicates a pressure due to the 12-inch rise. Assuming a cubic inch of water to weigh 0.036 pound, the gauge indicates a pressure of 12 x 0.036 = 0.432 pound. To reduce this pressure to ounces, multiply 0.432 by 16, the product will be the number of ounces; thus, 0.432 x 16 = 6.91, or very near 7 ounces. If you wish to construct a scale to indicate ounces, follow the instructions given in answer to Question 239, American Machinist, May 28, 1887.

(394) Subscriber, Camden, N. J., writes: Please advise me as to books for learning mathematics without a teacher. Also give price and where they may be procured. *A.*—Mathematics embraces a wide range of subjects, and to study the whole science will require quite a number of books. The science of mathematics treats primarily of the relations and measurement of quantities, and secondarily of the operations and processes by means of which these relations are ascertained. Mathematics, considered as the science of exact relation, is divided into three branches: 1, Arithmetic; 2, Geometry; 3, Analyses; Arithmetic is divided into two parts: 1, That which treats of the methods of representing and reading numbers by means of figures, together with the fundamental operations. The second part treats of the applications of the principles of the first part to the practical wants of life. Geometry has for its object the investigation of the properties and relations of magnitudes, by reasoning directly upon the magnitudes themselves or upon their pictorial representatives. Geometry is divided into two parts: Elementary Geometry

and Higher Geometry. The direct application of both branches of geometry are descriptive geometry, which has for its object the graphical solution of all problems involving three dimensions. A very extensive and useful branch of descriptive geometry is found in problems of shades, shadows, and mechanical drawing. A second application of descriptive geometry is found in perspective drawing. Analysis embraces all that part of mathematics in which the quantities considered are represented by letters, and the operations to be performed are indicated by means of signs or conventional symbols. Analysis is generally treated under the heads of algebra, analytical geometry and calculus. To commence the study of mathematics we would recommend the University Arithmetic, by Charles Davies; then the Elements of Geometry and Trigonometry by the same author. This book is generally known by the name of Davies' Legendre. In this study only the elements of Geometry, leaving the branch of Trigonometry until after you have studied the University Algebra, also by the same author: and then take up Trigonometry. If you have pluck and perseverance, we have no doubt as to your overcoming difficulties and mastering these subjects. Of course if you can obtain a teacher you will make faster progress. For price, go to any first-class bookseller.

(395) G. B., Newburgh, N. Y., asks: With what force in pounds or tons would a weight of 80 tons strike, if going at a rate of thirty miles an hour? Say, for instance, a weight of 80 tons placed in cars. Please give me the formula. *A.*—In an example of this kind we must also know the time during which the weight is brought to rest, because every shortening of the time of the operation is accompanied by an exactly proportionate increase in the force necessary to carry it out; this holds good always. Thus: Let f represent the force, t the time during which the body is brought to rest, m the mass of the body, which is equal to the quotient obtained by dividing the weight in pounds by 32.2. For the sake of brevity we shall, in this example, neglect the decimal .2, and only use 32. Let v represent the velocity in feet per second. In order to find the mean force with which the weight will strike, we use the following formula: $ft = mv$; from which we obtain

$$f = \frac{mv}{t}.$$

Let us first find the value of m. Say the total weight, including the weight of cars, is 80 tons; at 2,000 pounds per ton we have a total weight of 160,000 pounds; and

$$\frac{160{,}000}{32} = 5{,}000 = m.$$

The train running at 30 miles an hour will give us a velocity of 44 feet per second. Now suppose that it takes 10 seconds to bring the weight to rest; then, substituting numerical values for the symbols in the formula,

$$f = \frac{mv}{t}$$

we have

$$f = \frac{5{,}000 \times 44}{10} = 22{,}000$$

pounds, which is the mean force with which the weight will strike. If it takes five seconds to bring the body to rest, we have

$$f = \frac{5{,}000 \times 44}{5} = 44{,}000$$

And if it only takes one-half of a second to bring the weight to rest, we have

$$f = \frac{5{,}000 \times 44}{.5} = 440{,}000 \text{ pounds.}$$

(396) A. H. H., Mt. Sterling, Ill., writes: We wish to make a road carriage, and use for the motor a pair of 2" x 4" engines with about 4 feet driving wheels, and would like to get 10 or 12 miles an hour out of it, providing the boiler will not have to be too large. Will use coal oil, of about the medium grade, for fuel. I would like to know how to get at the heating surface, so as to construct the boiler myself. How many square feet of heating surface will be required? And how do you calculate the heating surface for a boiler? *A.*—For calculating the heating surface of a boiler, the usual practice is to find the number of square feet of surface exposed to the heat from the fuel. The area thus found will be the heating surface. Then allow from 10 to 15 square feet of heating surface for one horse-power. Good practice is to allow 15 square feet of heating surface for each horse power. In order to run the carriage at the rate of 12 miles an hour, with a four-feet driving wheel, the engine will have to make about 90 revolutions per minute. Assuming that the mean effective pressure in the cylinders is 60 pounds per square inch, each cylinder will then develop about ⅛ of a horse-power, making a total of ¼ horse-power for both cylinders. Allowing 15 square feet of heating surface for each horse-power, you will need a boiler with 10 square feet of heating surface. Of course, the foregoing rules will give only approximate results. If your engine is badly proportioned you may need more than 15 square feet of heating surface for each horse-power; on the other hand, for a well-constructed engine you may need less heating surface. Again, it should be remembered that the most effective heating surface in boilers with fire-boxes, is the heating surface in the fire-box. Generally, we may say that the evaporation of a boiler is dependent largely upon the construction of the boiler itself. In designing boilers for any specific purpose, elements of uncertainty will generally present themselves, which can only be overcome by experience; and consequently rules upon which absolute dependence can be placed in every case cannot be given. 2. What proportions of brass, copper, etc., will make a good wearing metal? *A.*—See Locomotive Brass Castings, AMERICAN MACHINIST, Oct. 29, 1887.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Wednesday for the ensuing week's issue.

See Grant's Gear advt. on back page.

Link-Belting.

Send for Catalogue of Link-Belting.

Over 50,000,000 feet of Link-Belt in use.

Link Belt Machinery Co., Chicago and N. Y.

See our new designed engine lathes in Cincinnati Centennial Exposition, Lodge, Davis & Co.

See our new designed drill presses in Cincinnati Centennial Exposition, Lodge, Davis & Co.

See our new designed shapers in Cincinnati Centennial Exposition, Lodge, Davis & Co.

See our new designed brass working tools in Cincinnati Centennial Exposition. Lodge, Davis & Co.

2,000 feet of space in Cincinnati Centennial Exposition, Lodge, Davis & Co.

See special adv't, page 16, Lodge, Davis & Co

Shafting Straighteners. J. H. Wells, Tampa, Fla.

Steel Name Stamps, etc. J. B. Roney, Lynn, Mass.

Lamb Knitting Machine Co., Chicopee Falls, Mass.

Machine work and pattern making. Anderson Machine Works, Peekskill, N. Y.

The Best Upright Hammers run by belt are made by W. P. Duncan & Co., Bellefonte, Pa.

Light articles built to order by the American Sewing Machine Co., Philadelphia, Pa.

The Improved Justice Hammer. Williams, White & Co., Moline, Ill., manufacturers.

R. Dudgeon, 24 Columbia st., New York, Improved Hydraulic Jacks and Roller Tube Expanders.

Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton and Dutch sts., New York.

"Swift" Sight-feed Lubricator: no glass tubes: simple, reliable. Swift Lub'r Co., Elmira, N. Y.

Davis Key-Seating Machines, kept in stock, by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

Drawings, mach. patterns and models. Inventors' ideas perfected. Valentine, 15 Alling st., Newark, N. J.

Selden Packing, for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N. Y.

Brown & Sharpe Mfg. Co. have a line of machinery with S. A. Smith, 23 S. Canal st., Chicago, Ill.

Patents—Whittlesey & Wright, 705 8th st., N. W., Washington, D.C. Send for pamphlet and references.

Ice and Refrigerating Machines, 124 built, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

For the latest improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago. Ill.

Engine lathes, hand lathes, fine tools, files and supplies for machinists and other metal workers. Frasse & Co., 92 Park Row, N. Y.

Special electric light for factories; large or small plants. Address The Waterhouse Electric and Mnufacturing Co., Hartford, Conn.

Patent Attorney. R. G. DuBois, 916 F st., Washington, D. C. Service at reasonable rates. Send for pamphlet containing list of references.

Machinists' supplies, brass goods, m'f'rs supplies, polishing materials, all kinds wire, metals, etc., in any quantity. Jordan & Gottfried, 208 Canal st., N.Y

For Best Return Steam Traps, Pressure Regulators, Positive-Acting Pump Govs., Back-Pressure Valves. T. Kieley, 11 W. 13th st., N.Y. Send for des'n.

Fine tools and supplies for machinists and other metalworkers. Get our prices before purchasing elsewhere. Montgomery & Co., 105 Fulton st., N.Y.City.

Curtis Pressure Regulators, Curtis Return Trap, Curtis Damper Regulator. See Aug. 4, p 11. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

Upright drills, improved, sizes 21", 23", 25", 28", 32", 36" swing; finely made and great capacity; write for cuts and prices. Currier & Snyder, Worcester, Mass.

W. H. Hoffman, consulting engineer, 108 Liberty st., room 3, N. Y. Mechanical engineering in all its branches; working drawings for the transmission of power by steam, water, air and electricity.

Contract work of all kinds executed promptly and on reasonable terms. Parties wishing gray iron castings in large quantities can make money by corresponding with Rawson Mfg Co., Hornellsville, N.Y.

A practical treatise on the steam engine, by Arthur Rigg, essays on the principles involved in design and construction of fixed engines; 312 pages, with 96 plates. 4to. cloth, $10.00. E. & F. N. Spon, 12 Cortlandt st., N. Y.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator, and making all required calculations from the diagram; also the principles of economy in operating steam engines, and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 15 Astor Place, New York.

"Binders" for the AMERICAN MACHINIST. Two styles—the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers, the full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUB'G CO., 96 Fulton st., New York.

The series of articles by J. G. A. Meyer, on "Practical Drawing," now running in the AMERICAN MACHINIST, should be closely followed by every student. They commenced with October 23, 1886 issue, and up to and including August 11, 1888 issue, 56 articles have been so far published. Copies containing these articles, sent by mail to any part of this country or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York.

"Modern Locomotive Construction," by J. G. A. Meyer. The above series of articles, now running in the AMERICAN MACHINIST, are attracting the attention of railway mechanics all over the world. Commencing with the June 27, 1885 issue, 70 articles have thus far appeared up to and including the August 4, 1888 issue. Copies containing these articles sent by mail to any part of the U. S. or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York.

MANUFACTURES.

The Cherryfield (Maine) Electric Light Company has organized, and has gone into business.

A fire at the Edson Machine Works, Schenectady, N. Y., damaged the foundry to the extent of $30,000.

The Excelsior Needle Company, Torrington, Conn., is fitting up to use petroleum for heating purposes.

The citizens of Akron, Ohio, have voted for the establishment of a $200,000 plant for the manufacture of fuel and illuminating gas.

The Simonds Manufacturing Company, Fitchburg, Mass., are busy, running overtime. Work on machine knives is particularly lively.

The Merrick Thread Company, of Holyoke, Mass., will probably build a spool factory at Schodac Lake, Maine. Timber for spools is abundant there.

William Corey will build a two-story factory, to be run with steam power, at Lake Village, N. H. He will use it in the manufacture of needles.

Rice & Hutchins are pushing work on their new shoe factory at Marlboro, Mass. The factory will be 44 x 200 feet, and 400 hands will be employed.

The American Electric Register Company has been incorporated at Portland, Me., by C. F. Howe, of Boston, C. A. Kellogg, of Newton, Mass., and others, with a capital stock of $200,000.

The Gardiner (Maine) Shoe Company has been organized, with a capital stock of $9,000, and the business of manufacturing will be commenced at once.

The Charter gas engine, made by the Williams & Orton M'f'g Co., Sterling, Ohio, is being sold quite extensively. This company also make a gasoline engine, which is said to be coming into favor.

The Greenfield Natural Gas Company, of Greenfield, Ind., has a proposition before the City Council to erect, maintain, light and turn out any number of street torches at the rate of $6 per year on a five years' contract.

Ground has been broken at Waldoboro, Maine, for the new shoe factory. The building will be of wood, 32 x 133 feet, four stories high, with basement. The work will be pushed on the structure, as the mill must go into operation this fall.

The Rogers Locomotive Works, of Paterson, N. J., have just completed an order for three locomotives for the Nashville, Chattanooga & St. Louis Railroad, and have also nearly completed three of an order for seven locomotives for the Long Island road.

The suit of the Webster Loom Company *vs.* E. S. Higgins & Co., of New York, for infringement of a patent process of carpet weaving, which has been pending fourteen years, was decided Friday in favor of plaintiff, but only six cents damages are awarded, instead of $30,000,000, as claimed.

The G. A. Gray Company, Cincinnati, Ohio, has issued a neatly illustrated and printed catalogue of machine tools made by that firm. The engravings are excellent and the descriptions good. The cover is illuminated with a cut of "The lathe of 100 years ago," contrasted with "The lathe of to-day."

Maine has fifteen paper pulp mills, the annual product of which amounts to 1,925,000, three-fourths of which is labor. This gives employment to three thousand men, the aggregate amount of whose wages is $1,443,750 yearly. In this branch of industry Maine is second only to New York State.

Eddy's steam lumber mills, with 8,000,000 feet of lumber, and about 50 small tenement houses, occupied by mill hands, two miles from Ottawa, Ont., were burned recently. Estimated loss $250,000. The insurance, as far as can be learned, is $110,000 – $50,000 on the mills and $60,000 on the lumber, all of which had been sold in the United States.

Messrs. Zeller, Phelps & Swift, manufacturers of barb wire and disk harrows, and Mr. Geo. W. Packer, machinist, Sterling, Ill., have consolidated, and under the name of The Empire Manufacturing Company, have organized a stock company, with a capital of $50,000, for the manufacture of the articles formerly made by each. Mr. Packer is the president of the company.

An enterprising Lynn (Mass.) shoe manufacturer has in contemplation the erection of a one-story factory, with from 15,000 to 20,000 feet of floor space, on the Alley street extension, between the Revere Beach and West Lynn, Boston & Maine depots. The one story factories are believed by many manufacturers to be the most practicable.

The Olmstead & Tuttle Company, of Chicopee, Mass., has been chartered for the manufacture and sale of cotton and woolen fabrics and waste; capital, $100,000 in 1,000 shares; president, John Olmstead; treasurer, Frank E. Tuttle. The board of directors consists of the above and Mr. George M. Stearns.

The Hussey Re-Heater and Steam Plant Improvement Company, 15 Cortlandt street, New York, has issued a circular descriptive of their new compound feed-water heater. This is an adaptation of the Hussey re-heating principle to heating feed-water. Our readers are aware, most of them, that by this principle the heat of the escaping gases from the boiler is used for heating purposes. By the use of this heater it appears that the water can be heated to any temperature, due to the temperature of the escaping gases, and thus a large saving in fuel effected. The arrangement of the device appears to be very complete and mechanical. The circular will be sent free to engineers and others interested in saving fuel.

A Hartford (Conn.) dispatch says: There is war here between the horse railroad and telephone companies. The railroad company want to adopt the Sprague system of electric street cars, a fundamental requirement of which is that the rails shall be highly charged with electricity. Objections set against this change are: The danger to which every passenger, animal and person crossing the tracks is exposed; the attack upon the telephone system, both above and below ground, and the prospects of suits against the city brought by the telephone company for damage to its system. The source of all annoyance is the use of rails as part of the circuit, which is cheaper than setting another wire overhead. The local manager of the telephone company, Mr. Ives, says that his company will resist every attempt to establish a system which charges the rails

Wm. T. Bate & Son, of Conshohocken, Pa., have three 120 feet and one 60 feet of their patent steam generators now on the floor. Among other work, they are now making one of 75 horse-power for the Electric Light and Power Company, of Conshohocken, and furnishing everything, including stack, flues, and brickwork. Also a 60 horse-power boiler for A. Borgner's canning works, Camden, N. J. They lately put a new style portable boiler in the Martha Washington, an excursion propeller boat plying on the Schuylkill river. The boat is 70½ x 14 feet, the engine is 10 x 10 inches, and boiler is only 32" diameter by 9 feet 4 inches long. Its steaming qualities are described as most remarkable. Like all of the other old-fashioned boiler makers who insist on doing good work or going fishing, the senior member of the firm, a veteran of 70, complains of the extremely low prices at which many alleged boilers and some real ones are now offered in the market.

The Wood Engine and Machine Company have equipped a foundry [at St. Louis, Mo.] and are operating the same in connection with their machine shop. Business with them is extremely active, so much so that they are crowded to their utmost capacity to care for orders. Included in the work just completed or in hand an *Age of Steel* representative noticed the following in a tour of the shops: A worm hoister engine, built from designs of Mr. Wood, of the company, for raising and lowering the Worthington pumps at the low-service station at the city water-works, on the inclined plane on which the same are placed: a Reilly improved steam pump of large size, recently patented, for the American Brake Company; cob-pipe machinery of entirely new pattern, consisting of several machines, and designed, among other things of novel character, to compress the cobs during the process of manufacture; building contractors' hoisting engines, or "hod carriers" engines, etc. The Wood Company now control the Viernow patent for hoisting engines for the entire United States outside of St. Louis.—*Age of Steel.*

A press dispatch says: A special meeting of the stockholders of the Everett Mills Everett, Mass., was held this forenoon, to consider matters of capitalization. In the absence from the State of the president, Mr. James Longley, Mr. Augustus Lowell was elected chairman. The meeting was well attended and the stock was largely represented. The scheme proposed by the directors was adopted by a nearly unanimous vote, only 57 votes being thrown in opposition. The adoption of the scheme was carried out by voting affirmatively on the following, which constituted the form in which the business was presented: To consider and determine whether the Everett Mills will reduce its capital stock to the sum of $400,000; to consider and determine whether, after such reduction, the Everett Mills will increase its capital stock to $800,000, by issuing four thousand new shares of $100 each, and what other action, if any, it will take in respect to the reduction and increase of its capital; to consider and determine what measures, if any, shall be taken to carry into effect such reduction and increase, and for the disposal of the new shares. The directors were given full power in the matter. This proposed action is for the purpose of providing more active capital for the use of the company, and for the renovation, improvement and enlargement of the mills.

The Meadville (Pa.) *Tribune* has this to say of business there: Notwithstanding that July and August are considered dull months in the iron business, the several shops in this city report business as good, and a glance into three of the shops convinced a *Republican* scribe that such was the case. At the Barrett Vise and Tool Company's Works, on Arch street, everybody was found "hustling," the force being engaged at present in completing machinery for a large glass works at Fostoria, Ohio, of which Mr. Leon Houze, formerly foreman of the Meadville Glass Works, is manager and stockholder. Mr. James Barrett, of the firm, is at present in Muncie, Ind., placing and arranging machinery for another extensive glass works in course of erection there. The company have recently added several new tools of the most improved design, and anticipate a lively fall and winter business. A number of new machines have also been purchased and are now in use at the Hazlet Iron Works. Mr. John Hazlet, the genial proprietor, reports plenty of work to keep himself and workmen busy, and the outlook for the future as promising. At the Phœnix every department is booming, the boiler shop working overtime to keep up with orders.

Machinists' Supplies and Iron.

NEW YORK, Aug. 9, 1888.

Iron—American Pig—The main features of the market are much the same as have been prevailing for some weeks past, and there is little indication of increased demand or important change in prices. There is, however, a general feeling of hopefulness that trade will improve as the season advances, and it is generally admitted by buyers that prices are not likely to go lower than at present. We quote Standard Lehigh and North River brands $17.50 to $18 for No. 1 X Foundry, $16.50 to $17 for No. 2, and $15 to $16 for Grey Forge.

Scotch Pig—We quote Coltness, $19.50 to $19.75; Glengarnock, $19.25 to $19.50; Gartsherrie, $19.75 to $20; Summerlee, $19.25 to $19.50; Eglinton, $17.50 to $17.75; Langloan, $19 to $19.50; Dalmellington, $18 to $18.25; and Clyde, $19 to $19.50.

✲WANTED✲

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Wednesday morning for the ensuing week's issue.

Wanted—Men to examine S. S. planes; see p 11.

Experienced machine shop foreman desires situation; best of references. Box 13, AM. MACHINIST.

Mechanical draftsman, 14 years' experience on gen'l machinery, wants position. G., AM. MACHINIST.

Wanted—An experienced man to sell and erect feed-water heaters; references required. Address Box 14, AMERICAN MACHINIST.

Wanted—A position by a young machinist to learn mechanical drawing; understands a little about drawing. Box 10, AMERICAN MACHINIST.

Draftsman wanted for machine shop in Brooklyn, principally to make tracings; state age and experience. Address E. B., AMERICAN MACHINIST.

Wanted—Situation as draftsman, by young man of practical shop and drafting room exp. B. B. R., Room 6, State Banking Co's B'd'g, Newark, N. J.

Wanted—Mech'l draftsman and pattern maker; one who understands steam pumps. Address, stating age, exp., and wages expected, Box 450, DuQuoin, Ill.

Wanted—By a young man now in charge of a drafting room, a responsible position where he can get more active exercise. For particulars address M. C. D., AMERICAN MACHINIST.

Wanted—Position as foreman boiler maker, by a competent man who has been foreman a number of years and can give references as to ability, etc.; age 42 years. Address J. W. T., AMERICAN MACHINIST.

Good mech'l draftsman, first-class designer of light machinery for special purposes, young, educated, good character, wants position with professional parties where he will have opportunity to rise in the profession. References, AMERICAN MACHINIST.

A mech'l engineer, for 8 years in charge of the drawing room of a large establishment manufacturing engines, sugar mills, rolling mills, cotton compressors of 2,500 tons capacity, ice machines, etc., desires to make a change. Box 9, AM. MACHINIST.

Wanted—Situation as foreman or workman of a brass foundry, with a firm who runs one or two men; a man with family and strictly temperate; a practical workman on all kinds of metals; can give best of references. Address Box 11, AMERICAN MACHINIST.

Wanted—For good permanent position, a good man thoroughly experienced in the different branches of fine machine work and tool making; one having knowledge of drafting preferred. Address, stating age, etc., Charles Hutchinson, Detroit Electrical Works, Detroit, Mich.

Wanted—Position by a thoroughly competent draftsman, graduate from a high class tech. school; 12 years' experience in practical business as designer of shop tools and mach'y, also familiar with the construction of factory and mill buildings; very best references and testimonials. R. S., AM. MACHINIST.

Wanted—Situation by a man who has had thirty years' experience in machinery business as superintendent and salesman; is at present superintendent of machine shop; will be open for engagement after Sept. 15; references furnished if desired. Address W. E., Post Office Box 38, Hoosick Falls, N. Y.

Wanted—By an Ohio manufacturing concern, making heavy machinery and steam engines, employing forty to fifty machinists, a machine shop foreman, experienced in handling men and getting out first-class work at low cost; a permanent position open to the right man. Address, with salary desired, Box 12, AMERICAN MACHINIST.

Wanted—A thoroughly practical business man, who is somewhat acquainted with wood-working mach'y, and who has $5,000 to invest, to take entire management of an institution about to be started in a Western town. Other parties will furnish balance of capital of $25,000. The article to be m'f'd is covered by patents, and a market guaranteed for all the product. A liberal salary will be paid to the right party, who, besides his knowledge of mach'y, must have a knowledge of office affairs, and be prepared to take entire management of both office and shop. The best of reference will be required. Address J. A. L. AMERICAN MACHINIST.

✢ MISCELLANEOUS WANTS. ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion.

Light and fine machinery to order; Foot Lathe Catalogue for stamp. E. O. Chase, Newark, N. J.

D. J. Kelsey, M. E., designs machinery and iron structures; pat. drawings. 31 Ins. Bld., New Haven, Ct.

Correspondence solicited with parties having machine or foundry specialties to build. Honesdale Iron Works, Honesdale, Pa.

Wanted—To buy a good 2nd-hand milling machine, with overhanging arm; must be in good order and cheap. D. L. Bates & Bro., Dayton, O.

For Sale—A 20,000 lb. Stiles New Toggle Joint Drawing Press in first-class order. Apply Keystone Watch Case Co., 19th and Brown streets, Philadelphia, Pa.

Wanted—To buy second-hand lathes, planers and shapers of all sizes; must be cheap and in good order. Fosdick & Plucker, 6th and Culvert Streets, Cincinnati, O.

How to remove and prevent scale in steam boilers at a cost of ten cents a week. Send postal for circular to Pittsburgh Boiler Scale Resolvent Co., Pittsburgh, Pa.

For sale or manufacture on royalty, flue welder; welds in fire any size or length; can be manufactured cheap; illustrated in *Locomotive Engineer* for July. Address John N. Buchanan, Batavia, N. Y.

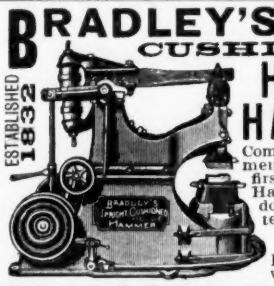
August C. Christensen, M. Am. S. M. E., 24 State st. (Battery), N. Y.; 463 Henry st., Brooklyn. Working drawings and superintending the building of machinery; steam, pumping and gas engines indicated.

E. W. Naylor, 149 B'way, N. Y., consulting eng'r. Designs for iron & steel work, mch'y, hyd. presses, cranes, etc.; R'y traffic & freight plant, warehouse & dock cranes & hoists; 20 y'rs' exp. best Eng. firms.

For Sale—Mach. shop, boiler, blacksmith and sheet iron shop, iron foundry and pattern shop in full blast; good mach'y, tools & patterns as required by the trade; one of the best known establishments in the South, established 1859; including buildings and ground; parties wishing to step into a business already established in a healthy city in the South will please address Lock Box 403, Nashville, Tenn.

BRADLEY'S UPRIGHT CUSHIONED HELVE HAMMER

ESTABLISHED 1832



Combines the best elements essential in a first-class **Hammer.** Has more good points, does more and better work and costs less for repairs than any other **Hammer** in the world.

BRADLEY'S HEATING FORGES.

ESTABLISHED 1832

With a manufacturing experience of over half a century, we recommend these machines to be the best, simplest, most durable and combining all the essential elements. **For hard coal or coke.** Indispensable in all shops. Pat. Aug. 30, 1887.

BRADLEY & CO. SYRACUSE, N. Y.

keep **Bradley's Cushioned Hammers** and men fully employed and reduces cost of production.

STEPHENS PATENT VISES.

ONE HALF TIME and LABOR saved by using this solid, strong, durable firm-hold, quick-working Lever (Not Screw) Vise. Has improved Taper-Pipe and other attachments. Sold by the trade. Send for circular.

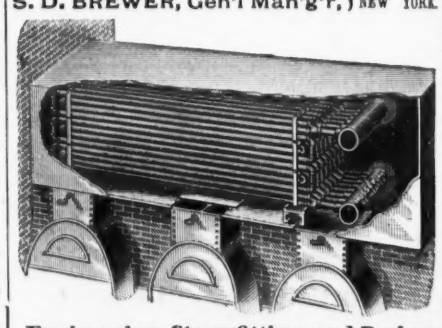
TOWER & LYON, 95 Chambers Street, New York. Successors to MELVIN STEPHENS.

FOR SALE. CORLISS ENGINES.

The Fishkill Landing Machine Co., located at **Fishkill,** on the Hudson, offer to manufacturers and others desiring a well built, economical and durable engine, their improved **CORLISS ENGINES.** They are endorsed by many reputable engineers and persons using them. Address as above.

THE HUSSEY RE-HEATER and STEAM PLANT IMPROVEMENT CO.

A. S. HATCH, President, } 15 Cortlandt Street,
S. D. BREWER, Gen'l Man'g'r, } NEW YORK.



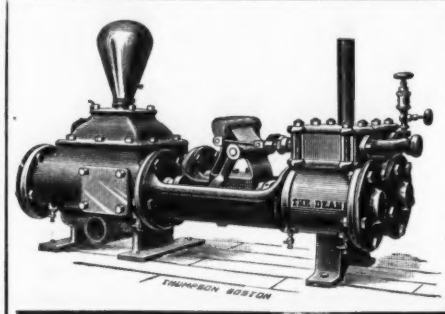
Engineering, Steamfitting, and Designing, Remodeling and Improving Steam Plants. Consulting experts in all matters pertaining to the use of Steam and Heat.

GEO. F. BLAKE MANF'G CO

BUILDERS OF EVERY VARIETY OF

95 & 97 LIBERTY ST., NEW YORK. 111 FEDERAL ST., BOSTON.

WATER WORKS PUMPING ENGINES A SPECIALTY



THE DEANE STEAM PUMP CO.,
HOLYOKE, MASS.,
New York, Boston, Chicago, Philadelphia, St. Louis,
Manufacturers of
STEAM and POWER
PUMPS
FOR ALL PURPOSES.
SEND FOR CATALOGUE.

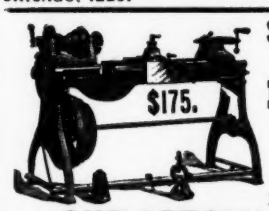
SHAPERS.

The Hendey Shapers are generally acknowledged to have more special features required in a Shaper than any other in the market. All efforts by unfair opponents to decry their merits have simply resulted in increasing their sale. To-day they are more popular than ever. They are also better than ever. Write us for Catalogue and Price.

Shapers, Planers, Engine Lathes, &c.
THE HENDEY MACHINE CO., TORRINGTON, CONN.

BEST CAST STEEL.

For MACHINISTS' TOOLS and DIES DOING CONTINUOUS HARD WORK.
MILLER, METCALF & PARKIN, CRESCENT STEEL WORKS,
CHICAGO, ILLS. PITTSBURGH, PA. NEW YORK, N. Y.

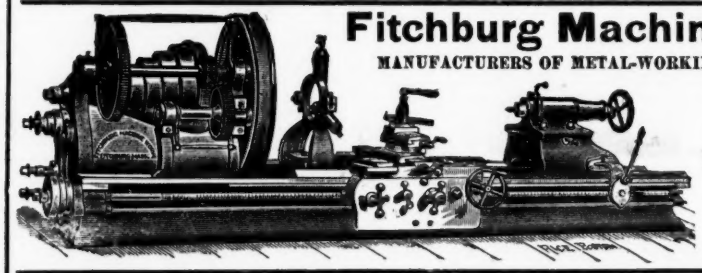


Sebastian, May & Co.'s Improved Screw Cutting FOOT AND POWER LATHES

Drill Presses, Shapers, Band, Circular and Scroll Saws. Machinists' Tools and Supplies. Lathes on trial. Catalogue mailed on application.
167 West Second Street, CINCINNATI, O.
OUR SPECIALTIES, 8, 12, 14 and 18 inch Lathes.

GUILD & GARRISON, Kent Ave. and South 10th St., Brooklyn, N.Y.
Builders of Steam Pumps, Vacuum Pumps, Vacuum Apparatus, Filter-press Pumps, Air Compressors, etc.

Fitchburg Machine Works
MANUFACTURERS OF METAL-WORKING MACHINERY.



OFFICE AND WORKS, 13 to 21 MAIN ST., Fitchburg, Mass.
SEND FOR CATALOGUE.

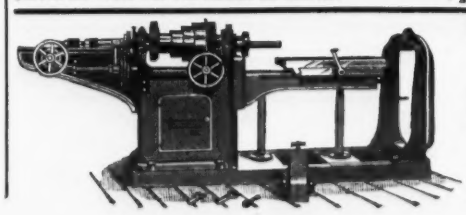
THE HILL AUTOMATIC SPRINKLER.
Best head made. Many in use. Approved by all Stock and Mutual Insurance Co's.
For Catalogues, prices or local agencies, address
HILL AUTOMATIC SPRINKLER CO.
COLUMBUS, GEORGIA.

"Star" Foot Lathe Swings 9x25 in. LATHE Screw Cutting Automatic Cross Feed, etc.
Scroll Saws, Circular Saws, Lathes Mortisers. LATHE Catalogue Free of all our Machinery.
Seneca Falls Mfg. Co. 687 Water St., Seneca Falls, N.Y

TANITE EMERY WHEELS and GRINDING MACHINES
FOR SAW MILLS, FOUNDRIES AND MACHINE SHOPS
For Circulars address
THE TANITE COMPANY, STROUDSBURG, MONROE CO., PA.
Or H. A. ROGERS, 19 John St., N. Y.

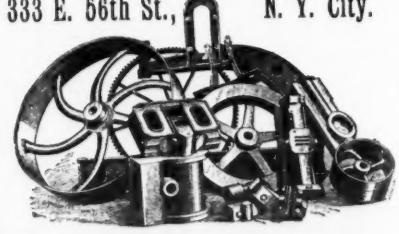
PRESSES, DIES AND OTHER SHEET-METAL TOOLS
FERRACUTE MACHINE CO. BRIDGETON, N. JERSEY, U.S.A.

HENRY CAREY BAIRD & CO.,
Industrial Publishers, Booksellers and Importers,
810 Walnut St., Philadelphia.
Our New and Revised Catalogue of Practical and Scientific Books, 80 pages, 8vo., and our other Catalogues and Circulars, the whole covering every branch of Science applied to the Arts, sent free and free of postage to any one in any part of the world who will furnish his address.

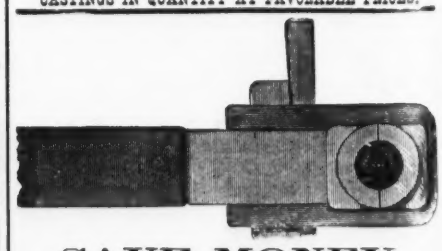


ROSE POLYTECHNIC INSTITUTE
TERRE HAUTE, IND.—A SCHOOL OF ENGINEERING.
Well endowed, well equipped departments of Mechanical and Civil Engineering, Electricity, Chemistry and Drawing. Extensive Shops and Laboratories. For Catalogue, address
T. C. MENDENHALL, Pres.

Iron Foundry of T. Shriver & Co.,
333 E. 56th St., N. Y. City.



Nice Castings, Smooth and True to Patterns, of very best brands of Pig Iron.
CASTINGS IN QUANTITY AT FAVORABLE PRICES.



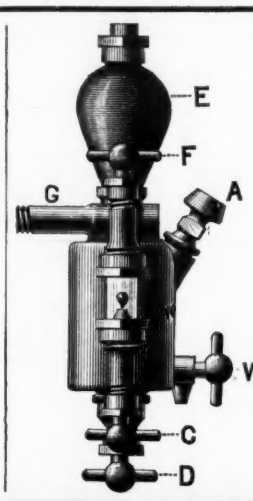
SAVE MONEY,
BY BUYING YOUR
STRAP JOINTS
FROM COOKE & CO.,
22 CORTLANDT STREET, NEW YORK.
WRITE FOR PRICES,
Mentioning *American Machinist.*

BETTS MACHINE COMP'Y,
WILMINGTON, DEL.,
MAKERS OF
Metal-working Machine Tools
OF SUPERIOR QUALITY,
FOR USE IN
MACHINE & RAILWAY SHOPS.

NICHOLSON FILE CO., Providence, R. I.

Manufacturers of FILES and RASPS.

In Quantity, greater than
In Quality, superior to } **any other Maker.**
In Variety, far ahead of
In Reputation—No File sells so easily.



THE "VOLUNTEER" UP-DROP, SIGHT FEED, LUBRICATOR,

(GATES PATENT.)

FOR STATIONARY ENGINES AND PUMPS OF ALL KINDS. LUBRICATORS FOR SINGLE OR DOUBLE CONNECTION.

PRICE LIST.

Nos.	1	2	3
Price	$10.00	$12.00	$15.00
Capacity	⅓ pt.	½ pt.	¾ pt.

NATHAN MANUFACTURING CO.,

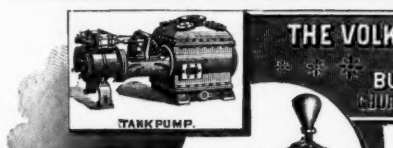
92 & 94 LIBERTY STREET, NEW YORK,

Send for Catalogue. **SOLE MANUFACTURERS.**

Established in 1874.

CLEVELAND TWIST DRILL CO.

24 and 26 West Street, Cleveland, O.
101 Chambers Street, New York.
85 Queen Victoria St., London, Eng.



THE VOLKER & FELTHOUSEN M'F'G. CO.

MANUFACTURERS OF
BUFFALO DUPLEX STEAM PUMPS.
CHURCH, BIRD & ALLEN STS. BUFFALO, N.Y.

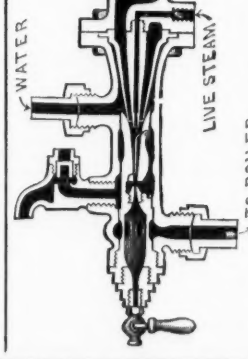
For Sale at Factory Prices by

A. Aller, New York; Walworth Construction and Supply Co., Boston; Henry I. Snell, Philadelphia; Thos. J. Bell & Co., Cincinnati; Shaw, Kendall & Co., Toledo; The George Worthington Co., Cleveland; Gouids & Austin, Chicago; Kennedy & Pierce Machinery Co., Denver, Col.; Sheriff & Ashworth, Pittsburgh, Pa.; Jos. Baur, Manistee, Mich.; Jas. Jenks, Detroit; Wickes Bros., East Saginaw; Adolph Leitelt, Grand Rapids; E. F. Osborne & Co., St. Paul, Minn.; Rundle, Spence & Co., Milwaukee; Joshua Hendy Machine Works, San Francisco; Flynn & Emrich, Baltimore; Forbes, Liddell & Co., Montgomery, Ala; Bailey & Lebby, Charleston, S. C.; Pond Engineering Co., St. Louis and Kansas City; O. B. Goodwin, Norfolk, Va.; Columbus Supply Co., Columbus, O.; C. S. Leeds & Co., Minneapolis H. D. Coleman, New Orleans.

Root's Force Blast Rotary Blower.

FOR
FOUNDRIES, SMITH SHOPS, PNEUMATIC TUBES, VENTILATION, ETC.

SLOW SPEED, POSITIVE BLAST, PERFECTLY BALANCED.
Best Mechanical Construction.
P. H. & F. M. ROOTS, Manufacturers,
CONNERSVILLE, IND.
S. S. TOWNSEND, Gen. Agt. } 22 Cortlandt St.,
COOKE & CO., Selling Agts. } NEW YORK.
In Writing, Please Mention This Paper.



THE SCHAFFER & BUDENBERG IMPROVED EXHAUST STEAM INJECTORS,

Adapted for working at pressures up to 120 lbs. and higher, are working with great success on Stationary Engines and Boilers, also on Steamers, Tugs, Dredges, etc., as they work WELL in the roughest weather.

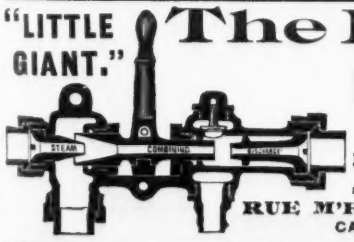
The ECONOMY IN FUEL shown over the ORDINARY LIVE STEAM INJECTOR has never been found LESS THAN 20 PER CENT. in actual practice.

SCHAEFFER & BUDENBERG,
40 John Street,
NEW YORK.

Sole Licensees and Manufacturers in the United States.

"LITTLE GIANT." The Best Injector.

For Feeding all Steam Boilers.



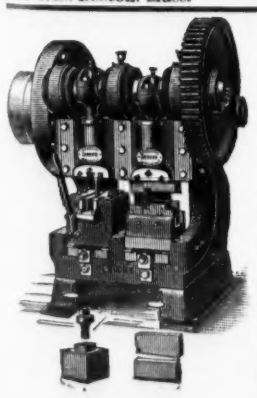
RUE'S ◦ EJECTOR,

Superior to all others for Raising and Forcing Water and other Liquids.

Boiler Washer and Testing Device. Uses Warm Water, avoiding injury and facilitating the Raising of Steam.

RUE M'F'G. CO., PHILA., PA.
CATALOGUES FREE.

"Twenty Years with the Indicator."—2 vols., $3.00. By THOS. PRAY, JR., C. & C. E. and C. & M. E. Six thousand sold. J. Wiley's Sons, 15 Astor Place, N. Y., or Thos. Pray, Jr., P. O. Box 2728, Boston, Mass.



BEAUDRY'S DUPLEX Power Press

COMBINING PRESS, SHEARS AND PUNCH.

BEAUDRY & CO.
(Formerly of Beaudry's Upright Power Hammer.)
Sole Manufacturers.
Also manufacturers of HARD COAL HEATING FORGES.
Room 4, MASON B'DG,
70 KILBY ST.,
Boston, Mass.

MACHINE TOOLS.

We have for quick delivery and in process of construction:
16 in., 20 in. and 24 in. Lathes.
14 in., 20 in. 33 in. and 49 in. Turret Head Chucking Machines. Screw or Stud Machines with Patent Friction Head, two sizes, 2⅛ in. and 2⅝ in. hole through spindle. Complete equipment of Box Tools and Dies for same.
Improved Center Bolt Cutting Machines.
37 in. and 50 in. Boring and Turning Mills, with single or double heads.
Special Heavy Turret Machines, with feed for Boring and Facing, with trip motion for each movement.
All from recent and carefully prepared designs. Workmanship guaranteed. Critical inspection invited.

ESTABLISHED SUMMER OF 1880.

BRIDGEPORT MACHINE TOOL WORKS,

E. P. BULLARD, Prop.
BRIDGEPORT, CONN.

Trains from Grand Central Depot, New York, hourly; time, one hour and thirty minutes.

REDUCED PRICES OF LeCOUNT'S STRAIGHT TAIL DOG.

To be driven from a Stud in the Face Plate.

No.	INCH.	PRICE.	No.	INCH.	PRICE
1	¾	$0.60	10	2¼	$1.35
2	⅞	.70	11	2⅜	1.45
3	1	.70	12	3	1.60
4	1⅛	.80	13	3½	1.80
5	1¼	.80	14	4	2.10
6	1⅜	.95	15	4½	2.75
7	1½	.95	16	5	3.25
8	1¾	1.10	17	5½	4.00
9	2	1.20	18	6	5.00
1 Set to 2 in.		7.80	Full Set		31.10

C. W. LeCOUNT, South Norwalk, Conn.

IMPROVED PATENT PORTABLE ROPE HOIST.

ONE MAN SUFFICIENT.

Quick lifting, quick lowering. Without touching hand rope, the load may be quickly lowered. Can be used for long or short lifts; will hold a load at any point.

ENERGY MFG. CO.,
1115 & 1123 S. 15th STREET, - PHILA., PA.

SEND FOR CATALOGUE.

WORCESTER MACHINE SCREW CO.

Manufacturers of Set, Cap and Machine Screws, Studs, etc.

Dean Bros Steam Pump Works. Indianapolis, Ind. Boiler Feeders, Duplex Pumps, Fire Pumps, Send for Catalogue

---

HALL DUPLEX STEAM PUMPS.

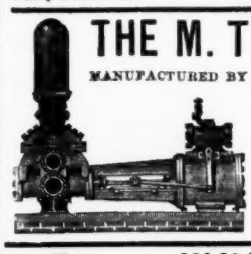
Send for New Catalogue.

Boiler and Pump Combined.

HALL STEAM PUMP CO.,

91 Liberty St., New York.

Fire Pump.



THE M. T. DAVIDSON IMPROVED STEAM PUMP

MANUFACTURED BY

DAVIDSON STEAM PUMP COMPANY.

WARRANTED THE **BEST PUMP** MADE FOR ALL SITUATIONS.

PRINCIPAL OFFICE, No. 77 LIBERTY STREET, N. Y.
NEW ENGLAND OFFICE, 51 OLIVER STREET, BOSTON, MASS.

WHY THIS IS PUT HERE!

For the reason that if you are interested in raising water or other liquids by steam power, we wish to call your attention to the

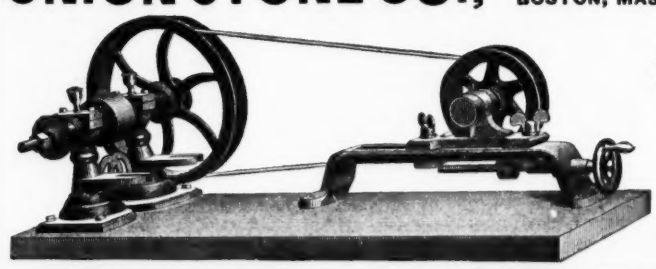
NEW PULSOMETER,

THE CHEAPEST AND BEST STEAM PUMP IN THE MARKET. PRICES LOWER THAN ANY OTHER.
More Efficient, Simple, Durable, and more Economical, both as to running expenses and repairs, than any other Steam Pump.

Call or write for our new 96 page Illustrated Descriptive Book containing Full Particulars, Reduced Net Prices, and hundreds of A-1 Testimonials. Mailed Free.

PULSOMETER STEAM PUMP CO., 120 LIBERTY ST., N. Y.

UNION STONE CO., 38 & 40 HAWLEY ST., BOSTON, MASS. 36 JOHN ST., NEW YORK.



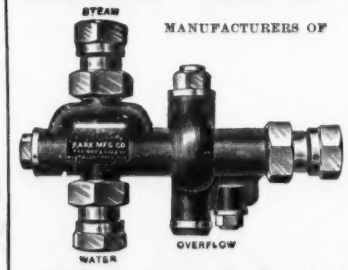
Endless Polishing Belt Machine for Removing Scale and Polishing irregular pieces of Work.

SIZES.
1½ in. wide.
2 " "
3 " "
4 " "

Endless Belts of Any Length and Width to order.

Send for Price List.

PARK MFG. CO.



MANUFACTURERS OF

34 Beach Street, Boston, Mass.

The Park Injector,

EJECTORS AND JET APPARATUS.

JOHN WILEY & SONS, 15 ASTOR PL. NEW YORK.

—PUBLISHERS OF—

SCIENTIFIC AND INDUSTRIAL WORKS.

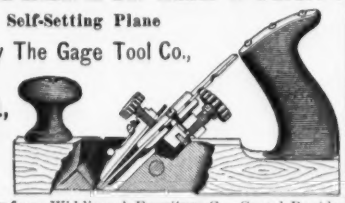
Send for Catalogues and Circulars.—Free by mail.

BEST PLANE IN THE WORLD.

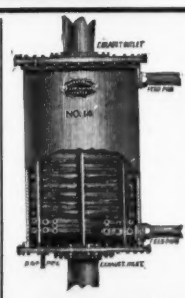
Only Self-Setting Plane

Made by The Gage Tool Co.,

Vineland, N. J.



Fifth order from Widdicomb Furniture Co., Grand Rapids, Mich: "Please ship us 6 more of your No. 2 Self-Setting Smoothing Planes. As soon as we commenced buying these Planes from you, about a year since, we found them almost indispensable, and our men like them very much."



THE NATIONAL Feed-Water HEATER.

A brass coil Heater delivering water to the boiler at 210° Fahrenheit.

100,000 Horse Power sold. Prices Low. Satisfaction universal.

THE NATIONAL PIPE BENDING CO.,
82 River Street, NEW HAVEN, CONN.

WORTHINGTON PUMPING MACHINERY

HENRY R. WORTHINGTON,

NEW YORK,
BOSTON PHILADELPHIA
CHICAGO ST LOUIS SAN FRANCISCO

SEND FOR Illustrated Catalogue.

Boilers for Export, or for Use in Undeveloped Regions.

Packed for Transportation on Mule back, in Cases weighing not over 275 lbs.
Easily erected. Self-contained. No brickwork required.
No rivets, expanded joints, calked seams, or packing.

HARRISON SAFETY BOILER WORKS,
GERMANTOWN JUNCTION, PHILADELPHIA, PENNA.

"STEAM"

A VALUABLE BOOK FOR EVERY STEAM USER AND ENGINEER.

PUBLISHED FOR FREE DISTRIBUTION, BY

THE BABCOCK & WILCOX COMPANY,

MANUFACTURERS OF

WATER-TUBE BOILERS,

107 Hope St., Glasgow. 30 Cortlandt St., N. Y.

THOS. H. DALLETT & CO.
1305 Buttonwood Street.
PHILADELPHIA, PA.
Portable Drills,
Hand Drills,
Boiler Shell Drills,
Light Drill Presses,
Special Machinery.
SEND FOR CATALOGUE.

PARIS UNIVERSAL EXPOSITION OF 1889

All persons, firms or corporations who desire to make exhibits at the above named exposition, are hereby notified that information and blanks for

APPLICATIONS FOR SPACE

will be furnished by the undersigned upon application to the undernoted address.

WM. B. FRANKLIN, Com'r General,
SOMERVILLE P. TUCK, Asst. Com'r General.
Office of the U. S. Commission,
Mills Building, 15 Broad Street and 35 Wall Street,
NEW YORK.

This System of Feed Water Heater is the Best

AND THE

LOWE

is the simplest
HEATER
on the system.
Has Straight Tubes
With reliable provision for expansion, and will
HEAT AND PURIFY THE WATER.
EQUAL TO ANY
With same Feet of Heating Surface and
Wear the Longest
Send for description and Histories of Boilers and Feed Water Heaters, to
Bridgeport Boiler Works,
Bridgeport, Conn.
Agents, THE POND ENGINEERING COMPANY,
St. Louis and Kansas City, Mo.

UNIVERSAL RADIAL RADIAL DRILLING MACHINES
THREE DESIGNS. SIX SIZES.
EMBODY ALL DESIRABLE FEATURES
PRICES $450.00 & UPWARD
ADDRESS UNIVERSAL RADIAL DRILL CO
CINCINNATI, O. U.S.A.

W. C. YOUNG & CO., Worcester, Mass. Manufacturers of
Engine Lathes, Hand Lathes,
FOOT POWER LATHES, SLIDE RESTS, ETC.

U. BAIRD MACHINERY CO.
Pittsburgh, Pa.

MACHINISTS' TOOLS AND SUPPLIES.
Pattern Makers' Tools. Boiler Makers' Tools.
STURTEVANT BLOWERS AND EXHAUST FANS.

EAGLE ANVIL WORKS,
Trenton, N. J.

The Fisher Double Screw Leg Vise.—Warranted stronger grip than any other Vise. Always parallel and cannot be broken.

Send for Circulars.

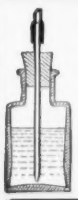
The Eagle Anvil.—Best Cast Steel Face & Steel Horn. Better than any English anvil. Fully warranted and lower price.

CURTIS & CURTIS,
Successors to FORBES & CURTIS,
66 JOHN ST., Bridgeport Ct., U.S.A.
MANUFACTURERS OF
The Forbes Pat. Die Stock,
Pipe Cutting and Threading Machine, etc.
A portable cutting and threading machine with which one man can with ease thread pipe up to six inch diam. No vise is required.
Send for Illustrated Catalogue.

VALUABLE PATENT FOR SALE.

A rare opportunity for a good business man with ample capital to engage in the manufacture of a staple article, which has already proven its merits. This will bear the closest investigation. Address
R. M. FULTON, Room 23 Ger. Am. Bank Building, St. Paul, Minn.

KEUFFEL & ESSER, New York.



INDELIBLE DRAWING INKS.

Black, Brown, Blue, Green, Scarlet, Carmine, Yellow.

The best ever produced. Have our Patent Ink Filler, which regulates supply to pen; prevents soiling outside of pen-blades; is the only cleanly device for filling pens. Sample assortment, seven vials (of above colors), mailed on receipt of 50 cents.

MACHINERY
For Reducing & Pointing Wire

Especially Adapted to Pointing Wire Rods and Wire for Drawing.
For Machines or information, address the manufacturer,
S. W. GOODYEAR, Waterbury, Ct.

PECK'S PAT. DROP PRESS.
NEW HAVEN
BEECHER & PECK. CONN.

DROP FORGINGS OF IRON OR STEEL
BEECHER & PECK, NEW HAVEN CONN.

MONTGOMERY & CO.,
105 FULTON ST., NEW YORK,
TOOLS, SUPPLIES AND MACHINERY
FOR ALL BRANCHES OF THE MECHANICAL TRADES.
Illustrated Catalogue (300 pages) mailed on receipt of Fourteen Cents.

HARDWICKE & WARE, Buffalo, N. Y.
Artesian, Salt and Oil Well Pumps, Sucker Rods and Deep Well Supplies.
WROUGHT IRON TUBING AND STEAM PIPE.

BAILEY'S PATENT COPPER CAP FUSIBLE PLUG.

A Cheap Means for Preventing Accidents to Steam Boilers through Low Water.

The **fusible metal is kept from contact with the water,** thereby avoiding the chemical and mechanical action, which would otherwise prevent it from melting. Cap is readily removable, permitting free inspection.

Highly recommended by the chief Boiler Insurance Companies of Great Britain. Over 150,000 sold in Europe since first introduced, with increasing sales. Highly recommended also by the U. S. Board of Supervising Inspectors of Vessels at Washington, D. C; by Prof. R. H. Thurston, and many other eminent expert engineers, as superior to any now in use, and filling all requirements. Highly recommended also by a number of master mechanics.

GEO. VAN WAGENEN, Sole American Licensee and Manufacturer.
Illustrated Pamphlets on Application. 233 West Street, New York City.

WESTCOTT CHUCK CO., Formerly Oneida Steam Engine & Foundry Co., ONEIDA, N. Y.

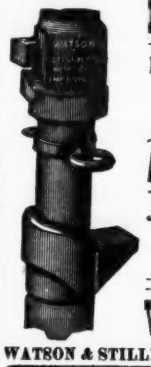
Manufacturers of all kinds of Lathe and Drill

CHUCKS

SEND FOR Catalogue.

Scroll Combination 3 or 4 Jawed. *Jaws reversible.* Diameter	Capacity.
4 9-16 in.	5 1-2 in.
7 1-2 in.	8 in.
10 1-8 in.	12 in.
13 1-4 in.	15 in.
16 in.	18 in.
18 1-2 in.	21 1-2 in.
21 1-4 in.	26 in.
24 in.	30 in.
30 in.	36 in.
36 in.	43 in.

WESTCOTT'S PATENT.



HYDROSTATIC MACHINERY,

PRESSES,
PUMPS,
PUNCHES,
ACCUMULATORS,
JACKS,
VALVES,
FITTINGS,
VAULT ELEVATORS, &c., &c.

WATSON & STILLMAN, 204-210 East 43d St., N. Y.

Before you buy a Lathe Chuck, examine the merits of "THE SWEETLAND." We do not claim the earth for it, but simply that it is better than any other Chuck on the market. Ask your dealer for it, or write direct to us. We guarantee you satisfaction. What more can we do?

THE HOGGSON & PETTIS M'F'G CO.
Est. 1849. NEW HAVEN, CONN.

CHAMPION SCROLL CHUCKS.

In 5 sizes, for foot Lathes and all classes of light work. Adopted as standard and kept in stock by the largest firms making such machinery. For sale at all supply stores. Ask for our Champion Chuck.

THE D. E. WHITON MACHINE CO.
NEW LONDON, CONN.

WELDLESS STEEL QUICK OPENING GATE VALVE. COLD DRAWN TUBES
SMOOTH INSIDE & OUT.
JOHN S. ENG. 4 Fletcher St. N.Y.

FLUOR SPAR THE BEST *Foundry* FLUX.

SEND FOR LIST OF USERS.

Evansville Spar Mining Co., Evansville, Ind.

WANTED TOOL AGENTS in Shops South and West of Penna. Send 10c. for Postage on Free Outfit.
C. B. JAMES, 98 Lake St., Chicago.
(Successor to E. H. RANDALL & Co.)

MACHINE TOOLS.

Special or General, any size, for the manufacture of Ordnance, Locomotive, Marine and Stationary Engines, Ships' Boilers, &c., supplied to many leading Firms in the United States of America.

Asquith's Patent Radial Drills

Unequaled by any in the World. Send specification of requirements. Large Stock of Tools ready for delivery.

W. ASQUITH, HALIFAX, England.

THE CAPITOL TOOL CO.,

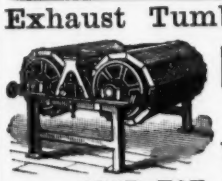
Hartford, Conn. P. O. Box 729.

MAKERS OF
SEYMOUR'S PATENT
Lathe and Planer Tool.

Without exception the best and cheapest Tool Made.

No forged or finished cutters. Will give perfect satisfaction. Ask your dealers, or send $2.45 and receive one with 4 cutters by return mail.

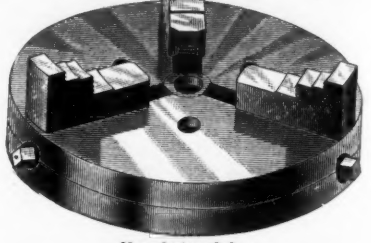
Exhaust Tumbling Barrels.



Henderson Bros.
MANUFACTURERS,
WATERBURY, CT.
SEND FOR CIRCULAR.

TRADE MARK.

THE HORTON LATHE CHUCK!



Manufactured by
THE E. HORTON & SON CO.,
Windsor Locks, Conn., U. S. A.
Send for Illustrated Catalogue.

A NEW CATALOGUE OF
CUSHMAN CHUCKS
JUST ISSUED.
Containing new designs. Sizes and prices sent free on application to the
CUSHMAN CHUCK CO.,
HARTFORD, CONN.

Emery Wheel 55 Styles & Sizes. Guaranteed Satisfactory.

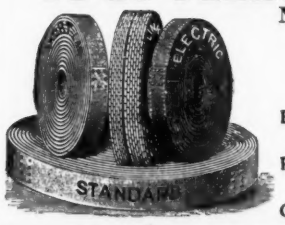
Tool Grinder.

SPRINGFIELD Glue & Emery Wheel Co. Springfield, Mass.

WRITE FOR Ill's'd Circular. No. D. Patented Sept. 25, 1883.

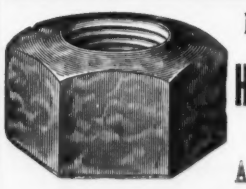
Water Prevents HEATING THE WORK.

CHAS. A. SCHIEREN & CO.,
MANUFACTURERS AND TANNERS OF
OAK TANNED LEATHER BELTING,
AND LACE LEATHER.
45-51 FERRY ST., New York.



BRANCHES:
Boston,
Philadelphia,
Chicago.

BALDWINSVILLE CENTRIFUGAL PUMP WORKS.
IRVIN VAN WIE, Prop.,
SYRACUSE, N. Y.
VERTICAL,
Horizontal & Suction Pumps.
Capacity 100 to 40,000 gals. per minute.
Sand Pumping Outfits a Specialty.



FINISHED
HEXAGON NUTS.
ACCURATE to GAUGE.
Orders Promptly Filled.
TRUMP BROS. M'CH CO.,
WILMINGTON, - - DELAWARE.

Universal and Plain Milling Machines,
Cylinder Boring and Facing Machines,
Universal Grinding Machines,
Patent Link Grinding Machines.
SPECIAL MACHINERY BUILT FOR ALL PURPOSES.
PEDRICK & AYER, 1025 HAMILTON ST., PHILADELPHIA, PA.

MORSE TWIST DRILL AND MACHINE COMPANY, New Bedford, Mass.

Manufacturers of **Morse Patent Straight-Lip Increase Twist Drills.**

Solid and Shell Reamers, Beach's Patent Self-Centering Chuck, Bit Stock Drills.
DRILL GRINDING MACHINES, MILLING CUTTERS AND SPECIAL TOOLS TO ORDER.

DRILLING MACHINES.

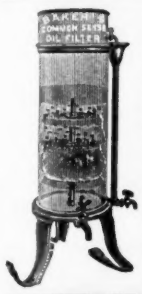
ALL STYLES WITH
Latest Designs and Improvements.
For cuts and prices address,

BICKFORD DRILL CO.,
Front & Pike Sts., Cincinnati, O.

WILLIAM BARKER & CO.,

Send for circulars and prices.

Manufacturers of
Iron and Brass Working MACHINERY
140 & 142 E. Sixth St., Near Culvert,
CINCINNATI, O.



BAKER'S COMMON SENSE OIL FILTER.

Is the most **Simple, Neat, Ornamental, Effective, Complete** and **Convenient OIL FILTER** in the Market. The whole **operation** is **visible,** and any ordinary man can operate it **successfully.** It will pay for itself the first year, if a little pains is taken to catch the waste oil from your Engine, Dynamo, Shafting, etc. etc. Manufactured and for sale by **CHAS. F. BAKER,**
223 Third Ave., S. E., MINNEAPOLIS, MINN

FRICTION CLUTCHES

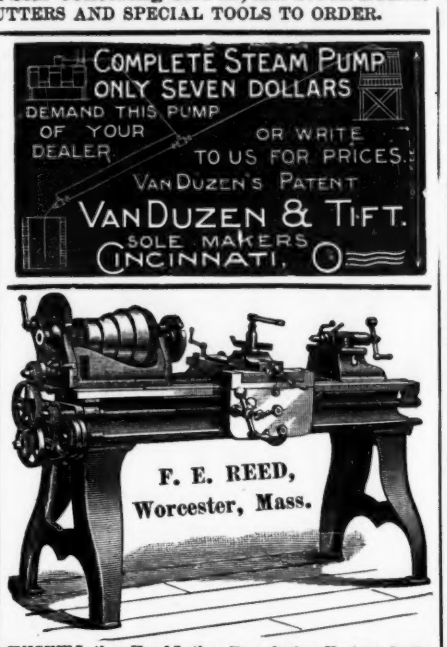
For all Purposes.

W. OESTERLEIN, 137 W. 2d ST.,
CINCINNATI, OHIO.

HUGO BILGRAM,

440 N. 12th St., Phila. Pa.
Maker of all kinds of
MACHINERY.
Special facilities for Accurate Work.

Bevel Gears cut theoretically Correct.



ENGINE Lathes, Hand Lathes, Foot Lathes, Upright Drills, and Milling Machines. Agents, MANNING, MAXWELL & MOORE, 111 Liberty Street, New York.

HODGE'S
Universal Angle Union

PATENTED.
Combining an elbow and union, and can be set at any angle at which it is desired to run the pipe.
Manufacturers & Wholesale Agents,
ROLLSTONE MACHINE CO., 45 Water St., FITCHBURG, MASS.

VOLNEY W. MASON & CO.,
Friction Pulleys, Clutches and Elevators.
PROVIDENCE, R. I.

SHEPARD'S NEW $60 SCREW-CUTTING FOOT LATHE.

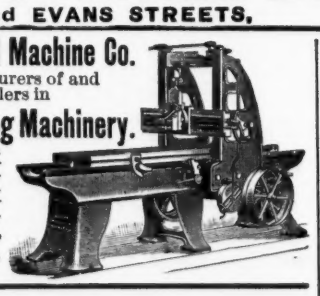
Foot and Power Lathes, Drill Presses, Scroll-saw Attachments, Chucks, Mandrels, Twist Drills, Dogs, Calipers, etc.
Lathes on trial. Lathes on payment.
Send for catalogue of Outfits for Amateurs or Artisans.

Address, H. L. SHEPARD, Agent, 134 E. Second St., Cincinnati, O.

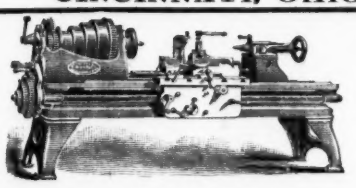
SEND FOR PHOTO OF OUR NEW AND IMPROVED
17 inch ENGINE LATHE,
COMPOUND REST AND TAPER ATTACHMENT.
HIGHEST GRADE OF WORKMANSHIP.
THE MULLER MACHINE TOOL CO.,
8TH and EVANS STREETS, CINCINNATI, OHIO.

L. W. Pond Machine Co.

Manufacturers of and Dealers in
Iron Working Machinery.



Improved Iron Planers a specialty. Feed, patented Feb. 9, 1886. Belt Shifter, patented Nov. 2, 1886.
140 Union St., Worcester, Mass.



NEW HAVEN MANFG. CO.

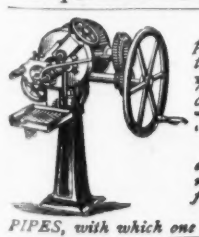
NEW HAVEN, CONN.
IRON-WORKING MACHINERY,
Planers, Shapers, Drills, Slotters, Etc.

L. S. STARRETT,

Manufacturer of
FINE TOOLS,
ATHOL, MASS.

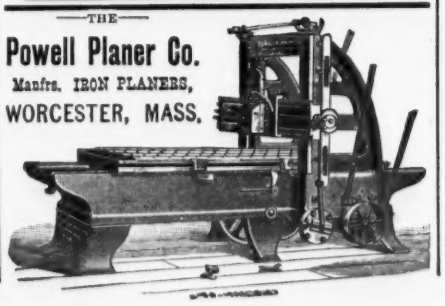
SEND FOR FULL LIST.

"Eclipse" Hand Pipe-Cutting Machines.



No. 1.—Powerful, inexpensive, simple in construction. Cuts and screws pipes ⅛ to 2-inch. Easily carried about.

"ECLIPSE" Nos. 2 and 3. These are powerful and most efficient machines for cutting large PIPES, with which one man can easily cut off and thread 6-inch pipe.
No. 2 Cuts and Screws 2½ to 4 in.
No. 3 " " " 2½ to 6 in.
It will pay you to write us for particulars.
PANCOAST & MAULE,
(Mention this paper.) Philadelphia.
We also build Power Machines.



FOR SMOOTH CASTINGS
THOMAS D. WEST
SAYS:—"COAT THE SURFACE OF THE MOLDS AND GATES WITH
Silver Lead or Plumbago.
THE BEST IS MANUFACTURED BY
JOS. DIXON CRUCIBLE CO.
JERSEY CITY.

D. SAUNDERS' SONS, Yonkers, N.Y.

Steam & Gas Fitters' Hand Tools.
SEND FOR CIRCULAR.

MANUFACTURERS OF
Pipe Cutting, THREADING, AND Tapping Machines,

THE PATENT WHEEL PIPE CUTTER shown in the cut combines simplicity with strength and lightness. Easily adapted to various sizes of pipe. Rolling instead of sliding motion. No loose parts to become detached and mislaid. All wearing surfaces are of tool steel hardened. Less friction of parts than any other pipe-cutter made.

Patent CALCULATOR, For Engineers.

Mechanical. Marine. Electrical. Mining. Hydraulic. Heating. Sanitary. Military.

Naval Constructors Architects. Builders. Mechanics. Assayers. Chemists. Scientists. Students.

Size 10x3¼x 1¼ in. Complete pocket book. Log. sines and tangents. Will be mailed on receipt of 75cts.

R. C. SMITH, No. 1 Broadway, N. Y.

CHARLES MURRAY
ENGRAVER ON WOOD
58 ANN ST. NEW YORK.

McMAHON & COMPANY.

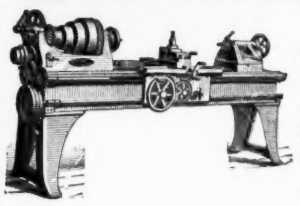
MANUFACTURERS OF

Machinists' Tools, AND Patent Friction Pulleys.
Water St., Corner Ledge,
WORCESTER. - - MASS.

BUFFALO FORGES

BLOWERS, EXHAUSTERS, HEATING FURNACES.
HAND BLOWERS, BLACKSMITH DRILLS.
BUFFALO FORGE CO.
BUFFALO, N.Y.

FACTS.

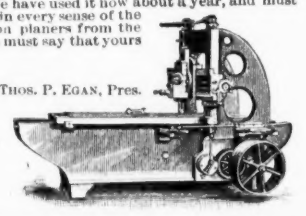


THE EGAN CO., CINCINNATI, OHIO, May 31, 1888.

THE G. A. GRAY CO., City.

GENTLEMEN:—In reply to your letter as to how we like the lathe and planer we have of yours, we will say that the lathe we bought of you is one of your smallest, but for the purpose we bought it, it has given first-class satisfaction. Now in regard to the iron planer, we would like to say that it far surpassed our expectations, and we consider it one of the most perfectly designed planers for strength and strain there is made. We have used it now about a year, and must tell you that it is an A No. 1 machine in every sense of the word. We are using a great many iron planers from the best shops in the United States, and we must say that yours is equal to any we have ever run.

Respectfully yours,
THE EGAN CO., Thos. P. Egan, Pres.



Catalogue, prices and photos sent upon application.
THE G. A. GRAY CO.
477, 479 & 481 SYCAMORE ST., CINCINNATI, OHIO.
A very nice display of our tools can now be seen at the
CINCINNATI CENTENNIAL EXPOSITION.

ELLIOTT DRILL PRESS
REDUCED TO
$85.00
QUALITY BETTER THAN EVER.
Send for our New Picture Book.
STERLING ELLIOTT, NEWTON, MASS.

Fit up your Boiler Shops, Bridge Works, Ship Yards, &c., with my "NEW" Standard
PUNCHES.
They will save you time and money.
I. P. RICHARDS, PROVIDENCE, R.I.

Section of **Copper-Wire-Sewed Light Double Belting,** specially adapted to use on cone pulleys and other hard places. Manufactured by the **PAGE BELTING CO., Concord, N. H.** Also manufacturers of Staple and Special Grades of Leather Belting, the *"PATNA BRAND"* Lacing, and the *"HERCULES"* Lacing. Send for Catalogue No. 2.

SHAPING MACHINES

FOR HAND AND POWER.
6", 8" and 10" Stroke.
Adapted to All Classes of Work to their Capacity.
Circulars Furnished.
BOYNTON & PLUMMER,
WORCESTER, MASS.

DELAFIELD'S PAT. SAW CLAMP

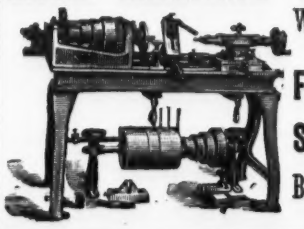
With Saw for Cutting Metals. Saves all the broken hack-saw blades. In use over two years in all parts of the country. The new Clamps have the edges beveled that hold the saw. Free by mail for 50 cents. Extra blades, 1-2 in. wide, 7c. each, 70c. per dozen; 1 in. wide, Stubs, 35c. each. Free by mail.
NOROTON MFG. WORKS, NOROTON, CONN.

ECONOMICAL STEAM BOILERS
A SPECIALTY.
SEND FOR PRICES. Pond Engineering Co. St. Louis, Mo.

BORING AND TURNING MILLS.
LATHES PLANERS DRILL PRESSES
F. P. MICHEL ROCHESTER N.Y.

GAGE MACHINE WORKS,

Waterford, N.Y.
Manuf'r's of
FOX, TURRET AND SpeedLathes AND Brass Finishers' TOOLS.



TO ADJUST SPEED

Of a steam pump so that, under varying conditions of load and pressure, it will keep an uniform speed, is what we guarantee to do with our Pump Governor. It has been on the market several years, and quantities are used by the leading pump makers.

MASON REGULATOR CO., Boston.

WILLIAM SELLERS & CO., Incorporated.

PHILADELPHIA, PA.

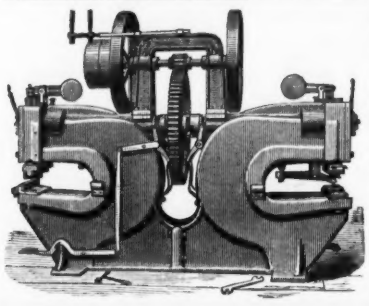
BUILDERS OF

MACHINE TOOLS FOR WORKING IRON AND STEEL,

Improved TURNTABLES for LOCOMOTIVES, CARS and PIVOT BRIDGES.

High Speed Power Traveling Cranes and Hand or Power Swing Cranes, Shafting, Pulleys, Hangers, &c., for transmission of power. Improved Self-Adjusting Injector of 1876. Self-Acting Injector of 1887. Fixed-Nozzle Automatic Injector of 1885.

INJECTORS for ALL CONDITIONS of LOCOMOTIVE and STATIONARY SERVICE.



THE LONG & ALLSTATTER CO. Hamilton, OHIO.

Double, Single, Angle-Bar, Gang, Horizontal, Twin, Boiler, Spacing, Gate, Multiple, Belt and Steam-Driven

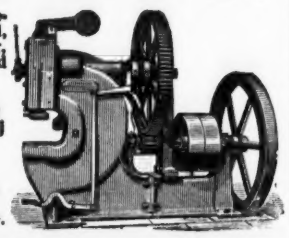
Punches and Shears,

Over 300 Sizes.

ALSO

Power Cushioned Hammer.

Send for New Catalogue.



All GENUINE INGOTS & MANUFACTURES BEAR OUR REG. TRADE MARKS.

"Phosphor-Bronze."

PHOSPHOR-BRONZE

INGOTS, CASTINGS & MANUFACTURES.

THE PHOSPHOR BRONZE SMELTING CO. LIMITED

512 ARCH ST. PHILADELPHIA PA. U.S.A.

ORIGINAL MANUFACTURERS OF PHOSPHOR-BRONZE IN THE UNITED STATES AND OWNERS OF THE U.S. PATENTS.

THE BECKETT & McDOWELL MFG. CO.,

ARLINGTON, N. J. S. A. BECKETT, GEN'L MANAGER

IRON FOUNDERS AND MACHINISTS.

MANUFACTURERS OF

STEAM ENGINES AND GENERAL MACHINERY. SPECIALTIES: ORE-CRUSHING MACHINERY, STAMP MILLS AND MINING HOISTS.

Having Extensive Foundry Capacity, we are prepared to contract for regular supply of Machinery Castings.

PURE CARBON BRONZE.

Heavy Journal Bearings our Specialty.

Specially adapted for use on Steam Engines, Heavy Machinery, Locomotives, &c.

Look for brand, "Pure Carbon Bronze."

CARBON BRONZE CO.,

SOLE MANUFACTURERS,

38 WATER STREET, PITTSBURGH, PA.

FORGING AND WELDING BY PETROLEUM AIR BLAST FIRES.

GREAT ECONOMY OVER COAL. SCALING AVOIDED.

Wear of DIES lessened, and better work produced. Insurance not increased. No ASHES or CLINKERS. Continuous fire the whole day. Correspondence solicited.

AERATED FUEL CO., - Springfield, Mass.

J. H. BULLARD, Gen'l Manager.

ALDEN SPEARE'S SONS & CO., Boston, Mass., Agents for Eastern part of New England.

HARRIS & COWDERY, Ashtabula, Ohio, Agents for Ohio.

PATENT OILERS, CYLINDER SIGHT FEED CUPS.

Government Regulation

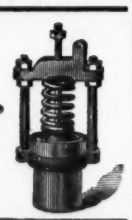
POP SAFETY VALVES,

For Stationary, Marine and Locomotive Boilers.

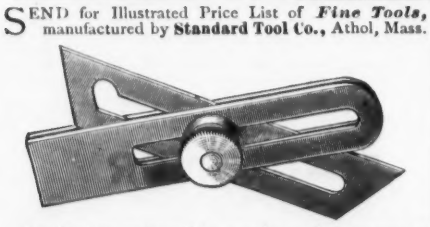
J. E. LONERGAN & CO., BRASS FOUNDERS AND FINISHERS,

211 Race Street, Philadelphia, Pa.

1888 CATALOGUE FREE ON APPLICATION.



SEND for Illustrated Price List of *Fine Tools*, manufactured by Standard Tool Co., Athol, Mass.



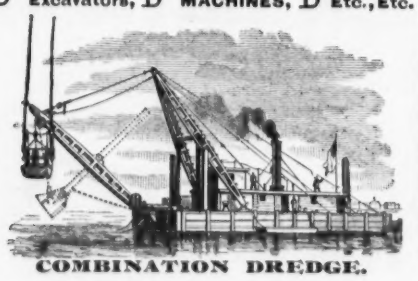
Any Tool we make will be sent by mail or express to any address, all charges prepaid, on receipt of price.

OSGOOD DREDGE CO., - ALBANY, N. Y.

RALPH R. OSGOOD, Pres. JAMES H. BLESSING, Vice-Pres. JOHN E. HOWE, Secretary and Treasurer.

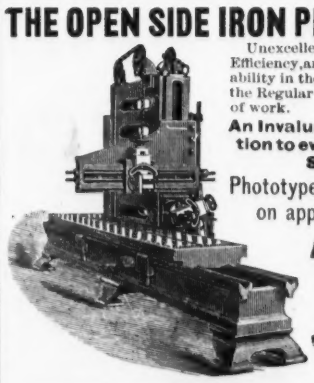
Manufacturers of

DREDGES, Excavators, DITCHING MACHINES, DERRICKS, Etc., Etc.



COMBINATION DREDGE.

THE OPEN SIDE IRON PLANERS.



Unexcelled for Accuracy, Efficiency, and general Adaptability in the performance of the Regular and Large class of work.

An Invaluable Acquisition to every Machine Shop.

Phototypes, prices, etc. on application to

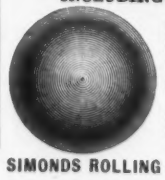
Detrick & Harvey,

Manufacturers,

BALTIMORE, MD.

SIMONDS ROLLING MACHINE CO.,

MANUFACTURERS OF ROLLED FORGED SPECIALTIES, INCLUDING



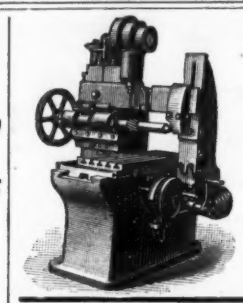
STEEL BALLS

For Anti-Friction Bearings, of Best Cast Steel, Hardened, Ground and Burnished, from 3-16 in. to 2 in. diameter.

In quality and density of metal, in uniformity of temper, and in accuracy and nicety of finish warranted unequaled.

SAMPLES AND PRICES ON APPLICATION.

SIMONDS ROLLING MACHINE CO., Fitchburg, Mass.



BEMENT, MILES & CO.,

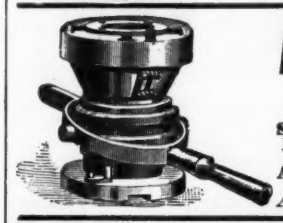
PHILADELPHIA, PA.

—BUILDERS OF—

METAL-WORKING MACHINE TOOLS

FOR

Railroad Shops, Locomotive and Car Builders, Machine Shops, Rolling Mills, Steam Forges, Ship Yards, Boiler Shops, Bridge Works, Etc., Etc.



ACME MACHINERY CO.,

CLEVELAND, OHIO.

Manufacturers of

"ACME"

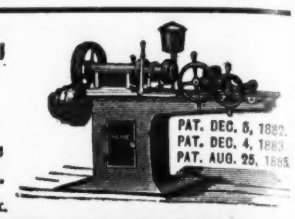
Single & Double Automatic Boltcutters,

Cutting from 3-8 in. to 6 in. diameter.

Also Separate Heads and Dies.

Send for Catalogues and Discounts.

Agents, Manning, Maxwell & Moore, New York.



BALL AUTOMATIC CUT-OFF ENGINES.

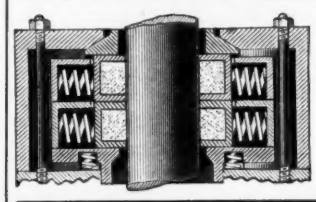
The characteristics of these Engines are Beauty of Design, Superior Finish, Limited Feet in Space required, Economy of Fuel, Perfection of Regulation.

CHARLES R. VINCENT & CO.,

NEW YORK SELLING OFFICE,

15 CORTLANDT STREET.

ANDREW GRAY, Pres. W. H. Hollis, Treas. E. P. MONROE, Gen'l Manager.



U. S. METALLIC PACKING CO.,

Philadelphia, Pa.

OFFICE, 133 S. 4th St. WORKS, 435 N. Broad St.

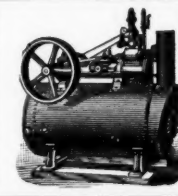
20,000 Packings in use on Locomotives, Stationary and Marine Engines.

FRICTION CLUTCH PULLEYS,

HOISTING ENGINES, ELEVATORS, STEAM AND BELT POWER.

THE D. FRISBIE COMPANY,

114 Liberty Street, - New York.



STEAM ENGINES

Upright and Horizontal, Stationary, Portable and Semi-Portable.

5 to 16 Horse Power.

Illustrated Pamphlet Free. Address

JAMES LEFFEL & CO

SPRINGFIELD, OHIO, or 110 Liberty St., New York.

FOR IMMEDIATE DELIVERY.

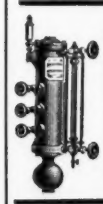
No. 3 BRAINARD MILLING MACHINE, Complete.

No. 3 DALLETT PORTABLE DRILL,

One 24"x24"x6' WHITCOMB PLANER.

TALLMAN & McFADDEN,

1025 Market Street, Philadelphia, Pa.



BOILER EXPLOSIONS and damage from too little and too much water can be obviated, while securing economical results, by using the RELIANCE SAFETY WATER COLUMNS. Warranted and sold by Boiler Makers and Dealers generally.

Send for Illustrated Price List.

RELIANCE GAUGE CO.,

27 EUCLID AVENUE,

CLEVELAND, OHIO.

SWEET'S Measuring Machine.

The only micrometer that will not lose its accuracy by wear.

Satisfaction Guaranteed.

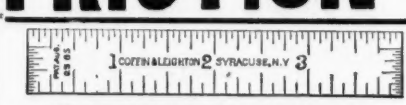
SYRACUSE TWIST DRILL CO.

Syracuse, N. Y.

FRICTION CLUTCH PULLEYS AND CUT-OFF COUPLINGS

JAS. HUNTER & SON,

North Adams, Mass.



MACHINIST'S SCALES,

PATENT END GRADUATION.

We Invite Comparison for Accuracy with all others.

EVERY SCALE GUARANTEED. SEND FOR LIST.

COFFIN & LEIGHTON, SYRACUSE, N. Y.

PATENT UNIVERSAL SCREW-CUTTING CENTER DEPTH ANGLE AND

J. WYKE & CO., TWIST DRILL GAUGE.

Fine Machinists' Tools.—E. Boston, Mass—Send for Circular.

J. A. FAY & CO. CINCINNATI, OHIO, U.S.A.

BUILDERS OF IMPROVED

WOOD-WORKING MACHINERY

Embraces nearly 400 Machines for

PLANING & MATCHING

Surfacing, Moulding, Tenoning, Mortising, Boring, and Shaping, etc.

Variety and Universal

WOOD WORKERS.

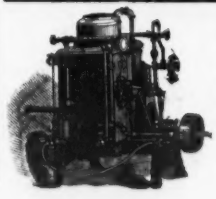
Band, Scroll and Circular Saws, Resawing Machines, Spoke and Wheel Machinery, Shafting, Pulleys, etc. All of the highest standard of excellence.

W. H. DOANE, Pres. D. L. LYON, Sec'y.

OUR NEW CATALOGUE OF TOOLS

And Supplies sent free to any address on receipt of Ten Cents in stamps (for postage.)

Chas. A. Strelinger & Co., WOOD AVE., Detroit, Mich.



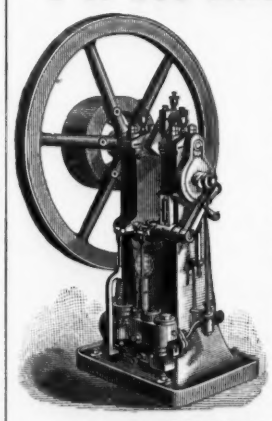
OIL ENGINES.

For Printers, Steam Yachts, pumping water, sawing wood, making ice-cream, Carpenters, Mechanics. 1 to 5 H.P. Fuel, Kerosene. No dust. Automatic in fuel and water supply. Illustrated Catalogue free. Mention AMERICAN MACHINIST.

SHIPMAN ENGINE CO., 92 Pearl St., Boston, Mass.

KORTING GAS ENGINE.

1 to 100 Horse Power.



The Korting Gas Engine is placed upon its merits and underfull guarantee to every purchaser.

CATALOGUES on APPLICATION.

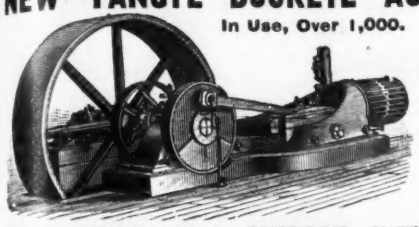
KORTING GAS ENGINE CO., LIMITED.

60 BARCLAY STREET

NEW YORK.

NEW TANGYE BUCKEYE AUTOMATIC CUT-OFF ENGINES.

In Use, Over 1,000. 25 to 1,000 H. P.



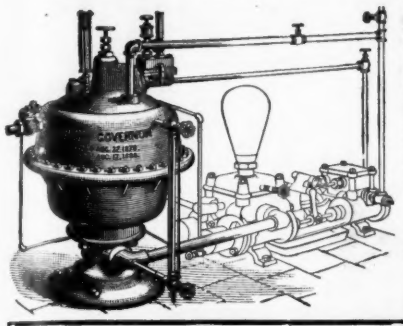
These engines are the combined result of long experience with automatic cut-off regulation, and most careful revision of all details. They are designed and constructed for heavy and continuous duty at medium or high rotative speeds. Highest attainable Economy in Steam Consumption and superior regulation guaranteed. Self-contained Automatic Cut-off Engines 12 to 100 H.P. for driving Dynamo Machines *a specialty*. Illustrated Circulars, with various data as to practical Steam Engine Construction and performance, free by mail. **Address, BUCKEYE-ENGINE CO., Salem, Ohio.**

SALES AGENTS: **W. L. SIMPSON,** 301 TELEPHONE BUILDING, 18 CORTLANDT STREET, N. Y. | N. W. ROBINSON, 154 Washington St., Chicago, Ill. ROBINSON & CARY, St. Paul, Minn.

KENSINGTON ENGINE WORKS, LIMITED, PHILADELPHIA.

Sole Licensees and Manufacturers for New Jersey (South of Trenton), Eastern Pennsylvania, Delaware, Maryland and Virginia.

BLESSING'S PUMP GOVERNOR.

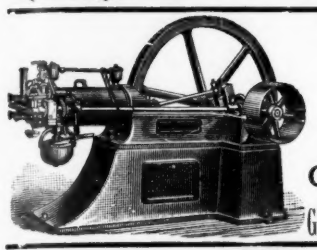


For use in returning the water of condensation to steam boilers under circumstances which make the employment of the steam trap undesirable, as where the pressure in heating systems is greatly reduced below boiler pressure, or where sufficient head room is lacking. Is used in connection with a steam pump, so controlling the action of the pump that its piston speed is at all times exactly proportionate to the varying quantity of water to be returned. No stuffing boxes are used in its construction, and friction is reduced to a minimum. Can be adapted to suit a wide range of conditions.

Send for circular of **Blessing's Albany Steam Trap, Blessing's Water Circulator and Purifier, and Blessing's Renewable-Seat Stop and Check Valves.**

ALBANY STEAM TRAP CO., Albany, N. Y.

"OTTO" GAS ENGINE WORKS.



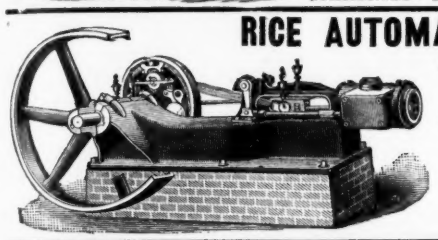
SCHLEICHER, SCHUMM & CO.,

33d and Walnut Sts. PHILADELPHIA. Branch Office, 130 Washington St. CHICAGO.

OVER 25,000 ENGINES IN USE.

GUARANTEED To Consume 25 to 75 Per Cent. Less Gas than ANY Other Gas Engine doing the same work.

RICE AUTOMATIC CUT-OFF ENGINE.

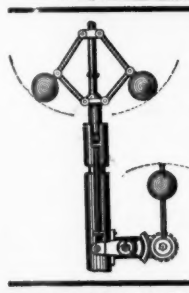


Self-Contained. Sensitive Governor. Balanced Valve. High Speed. Stationary Oilers. Best Economy.

Gold Medal Cincinnati Exposition, 1884.

THE JOHN T. NOYE MFG. CO.,
BUFFALO, N. Y.

WILSON'S



SPEED CONTROLLER,

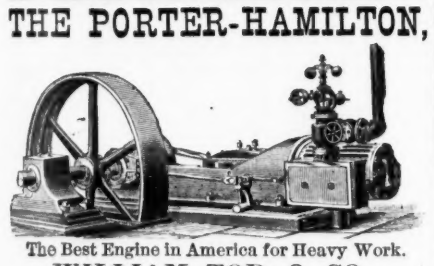
As attached to the Governor of a Corliss Engine, made only by

Remington Machine Co.,

BUILDERS OF CORLISS ENGINES, BOILER MAKERS AND BRASS FOUNDERS.

Wilmington, Del.

THE PORTER-HAMILTON,



The Best Engine in America for Heavy Work.

WILLIAM TOD & CO.,
Youngstown, Ohio.

MACHINERY ON HAND.

16 in. x 42 in.	Planer.	Bridgeport,	new.
20 in. x 4 ft.	"	New Haven,	fair.
20 in. x 5 ft	"	Ames,	good.
22 in. x 4-5 and 6 ft.	"	Powell,	new.
24 in. x 6 ft.	"	Powell,	"
30 in. x 8 ft.	"	each Atherton, Powell & H. & P.	new.
37 in. x 8 ft.	"	Fitchburg,	good.
38 in. x 14ft	"	Enterprise,	cheap.
60 in. x 12 ft.	"	G. W. & W. Screw,	good.
11 in. x 4 ft.	Engine Lathe,	Prentice,	good.
12 in. x 6 ft.	"	Young,	new.
13 in. x 6 ft.	"	Ames,	"
14 in. x 6 ft.	"	Blaisdell,	"
14 in. x 7 ft.	"	Bogart,	"
14 in. x 6 ft	"	Gap Bed, S. M. & Co.,	"
15 in. x 6 and 8 ft.	"	Porter,	"
16 in. x 6 ft.	"	Ames,	A 1
16 in. x 6 and 8 ft.	"	Blaisdell,	new.
16 20 in. x 6-8-10 & 12 ft.	"	Bridgeport,	"
18 in. x 8-10-12 ft.	"	Different Makes,	"
20 in. x 8-10-14ft.	"	Different Makes,	"
20 in. any length Bed	"	Bridgeport,	"
22 in. x 12 ft.	"	Niles,	heavy.
23 in. x 8-10-12 & 14 1 2	"	Bridgeport,	new.
26 in. x 12 ft.	"	Wright,	new.
24 in. x 14 & 20 ft.	"	Ames,	"
36 in. x 14 ft.	"	Fifield,	"
20 in. Drill		Davis,	"
20-25-28 inch Drills		Blaisdell,	"
20-25-28-32 inch	"	C. & S.	"
5 ft. Arm Universal Radial Drill,			"
No. 1 and 3 Universal Miller,		Brown & Sharpe,	"
No. 1-2 and 6 Plain	"	" "	"
No. 1 Universal Grinder,		" "	"
Die Sinker, No. 2,		P. & W.	A 1.
No. 3 Surface Grinder,		Brown & Sharpe,	A 1.

Cold Rolled Shafting in Stock. Send for list. Write for what is wanted.

E. P. BULLARD,
62 COLLEGE PLACE & 72 WARREN ST., N. Y.

Sterling Emery Wheel Co.,
Factory, West Sterling, Mass.
Office, 17 Dey Street, New York.

Our Wheels for Machine Shop Work and Tool Grinding Superior to all others.

Send for Catalogue just published.

Chicago Office, 41 South Canal St., Chicago, Ill

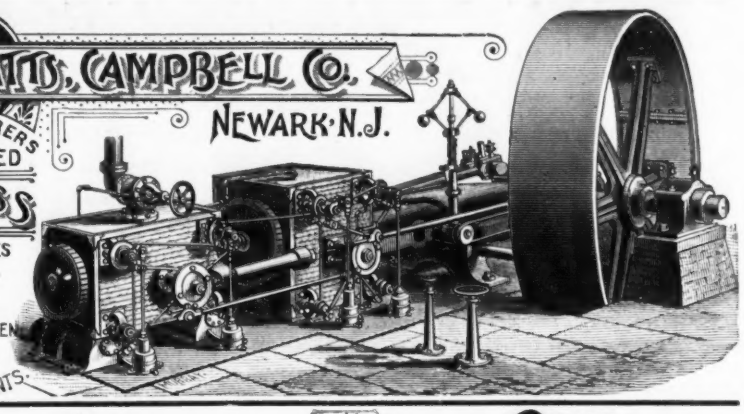
COIL-BOILERS FOR THE UNITED STATES NAVY.—NAVY DEPARTMENT, Washington, D. C., August 2, 1888.—The Navy Department, having in view the possible decrease in weight of machinery in vessels of war by the use of tubulous, sectional or coil-boilers, has determined to adopt such boilers, if suitable can be found, for a portion of the steam-power of one or more of the vessels about to be built. To this end, manufacturers who wish to offer such boilers for use by the Department are hereby invited to furnish plans of the same, adapted to an armored coast-defense vessel, on or before September 15, 1888. Plans must be accompanied by certificates that boilers of the same make are or have been in successful use at sea or on shore. Plans showing the space in the vessel available for boilers, particulars of the duty required, and other information, may be obtained upon application to the Bureau of Steam Engineering. The boiler which appears to the Department, after investigation, to be the best for the purpose, taking into account the evaporative efficiency, the dryness of the steam, the weight of the boiler, the weight of the water contained, the accessibility for repairs, the ease of making repairs, the simplicity and interchangeability of the parts, the space occupied, the ease of firing and of regulating the feed, the suitability for working in battery, the capability of long-continued steaming without cleaning, and the durability, will be adopted in the coast-defense vessel above mentioned, provided that the price, which must be stated when the plans are submitted, is satisfactory to the Navy Department. Such boilers as appear to possess merit will be tested by the Navy Department, if the manufacturers so desire, to determine which is the more suitable for the purpose. Manufacturers who wish their boilers to be tested must furnish a boiler of the type of one of those proposed for the vessel and prepare it for test, either at their own works or at such place as may be arranged with the Department. The expense of the test of the accepted boiler will be borne by the Navy Department, and the cost of the fuel used in the test of the second best will also be borne by the Navy Department. All other tests must be at the expense of the parties offering boilers for competition.

WILLIAM C. WHITNEY,
Secretary of the Navy.

THE WATTS, CAMPBELL CO.

MANUFACTURERS OF IMPROVED CORLISS STEAM ENGINES IN FULL VARIETY.

NEWARK, N.J.

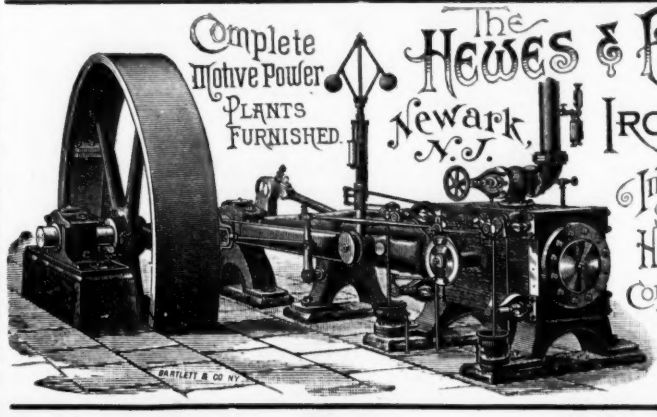


CONTRACTS TAKEN FOR COMPLETE POWER PLANTS.

The HEWES & PHILLIPS IRON WORKS

Complete Motive Power Plants Furnished.

Newark, N.J.



Improved CORLISS ENGINES. High Pressure, Condensing and Compound. TUBULAR BOILERS.

GEO. A. BARNARD, AGENT.

Eclipse Corliss Engine.

FRICK COMPANY, Builders,
WAYNESBORO, PA.

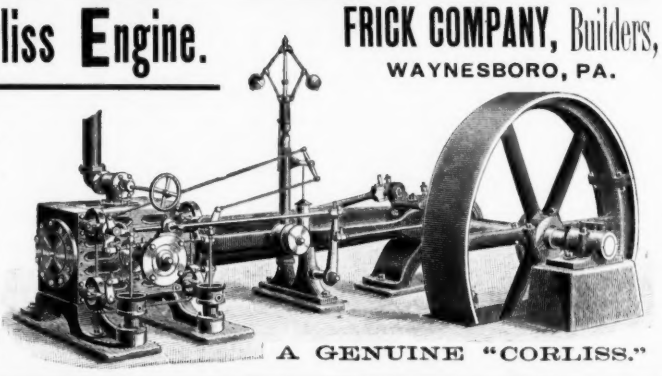
NON-CONDENSING, CONDENSING COMPOUND.

40 TO 1,000 H.P.

Send for Circulars.

E. P. HAMPSON & CO.,
36 CORTLANDT ST.,
NEW YORK,
Sole Eastern Agents.

JOHN J. METZGER,
69 S. Clinton St., Chicago,
WESTERN AGENT.



A GENUINE "CORLISS."

ROBERT WHITEHILL,

NEWBURGH, N.Y.

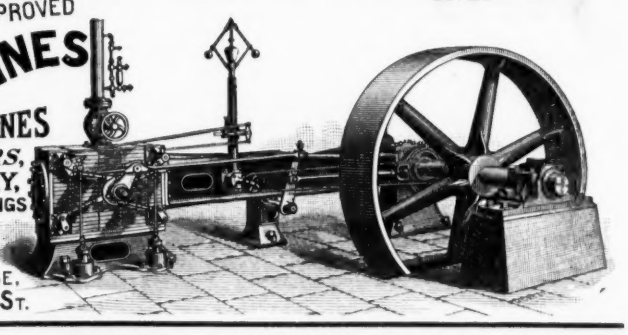
MANUFACTURER OF IMPROVED

CORLISS ENGINES

ALSO SLIDE VALVE ENGINES

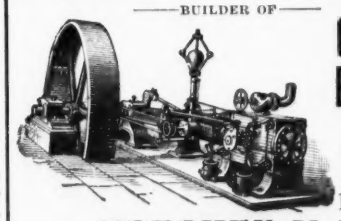
STATIONARY BOILERS,
GENERAL MACHINERY,
IRON AND BRASS CASTINGS

NEW YORK OFFICE, ROOM 6, COAL AND IRON EXCHANGE, COR. CORTLANDT & CHURCH ST.



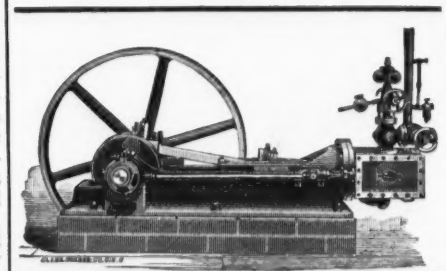
JOHN McLAREN,

BUILDER OF



CORLISS Engines, AIR Compressors and BOILERS.

HOBOKEN, N. J.



STEARNS M'F'G COMPANY,

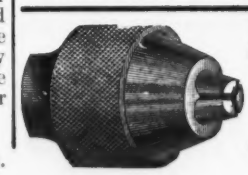
ERIE, PA.

ENGINES from 15 to 400 Horse Power.

Boilers of Steel and Iron supplied to the trade or the user. Send for Catalogues.

SAW MILLS and GENERAL MACHINERY.

Works at Erie, Pa.
New York Store, 46 Cortlandt Street,
BARNHURST & DURLIN, Managers.



Almond Drill Chuck,

Sold at all Machinists' Supply Stores.

T. R. ALMOND,
83 & 85 Washington St., Brooklyn, N. Y.

American Standard Gauge & Tool Works, Wilmington, Del.

Makers of Implements for Standard Measurements.

Over 35,000 in Use.

Crescent Gauge. Flat Bar Gauge.

JAS. A. TAYLOR & CO.

1888 CATALOGUE

ILLUSTRATING

MACHINERY

For Working and Cutting Iron, Brass and Steel,

IS NOW READY.

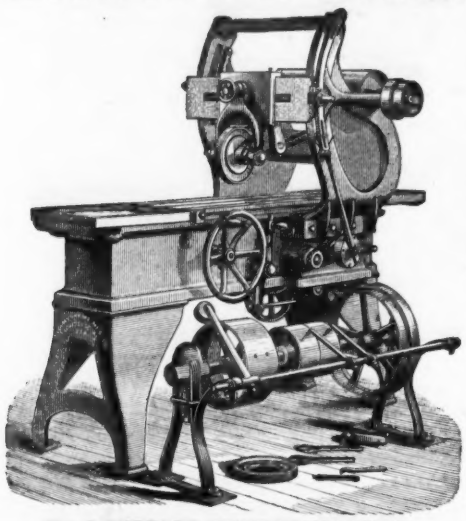
Contains 420 Pages, over 200 fine Wood Cuts, nearly all new and made specially for this book.

PRICE EACH, - $5.00.

(Copies will be sent, without expense, to all our customers, also to owners of machine shops, and intending purchasers, who may apply for them.)

HILL, CLARKE & CO.
156 OLIVER STREET,
BOSTON, MASS.

BROWN & SHARPE MFG. CO.



No. 3 SURFACE GRINDING MACHINE.

Manufacturers of

MACHINERY AND TOOLS,

PROVIDENCE, R. I.

This Machine is designed for flat and true surface grinding and finishing. It is an effective substitute for the operations of filing and stoning. The entire cost of files, and three-quarters of the labor usually expended on these operations are saved, besides obtaining better surfaces upon the work done. For all finished parts of machinery of cast iron or steel, hard or soft, for punches or dies, straight edges, flattening dies, etc., it will prove invaluable, and will produce fine work with little expense.

It will Grind 14" wide, 36" long, 10" high, using a 9" wheel.

The countershaft has tight and loose pulleys 8" diam., 4" face, and should run about 276 turns per minute.

Price includes countershaft, wrenches, etc.; all complete, delivered F. O. B. at Providence, R. I. Weight, 2,500 lbs.

We are prepared to furnish this machine lengthened, to grind 5 ft. long. Weight, 3,000 lbs.

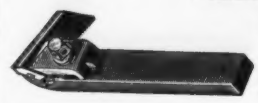
Illustrated CATALOGUE Mailed on Application.

WESTERN AGENT,

S. A. Smith, 23 S. Canal St., Chicago, Ill.

THE PRATT & WHITNEY CO.

HARTFORD, CONN.,



Manufacture Gardner & Woodbridge patent and new Threading Tool, Rhodes' Square Thread Tool, Woodbridge Lathe and Planer Tool, Johnson's Cutting-off Tool, Kidd's Improved Dividers and Adjustable Caliper Gauges.

WESTERN BRANCH, 100 West Washington Street, Chicago, Ills.

THE BILLINGS & SPENCER CO.

HARTFORD, CONN. U.S.A.

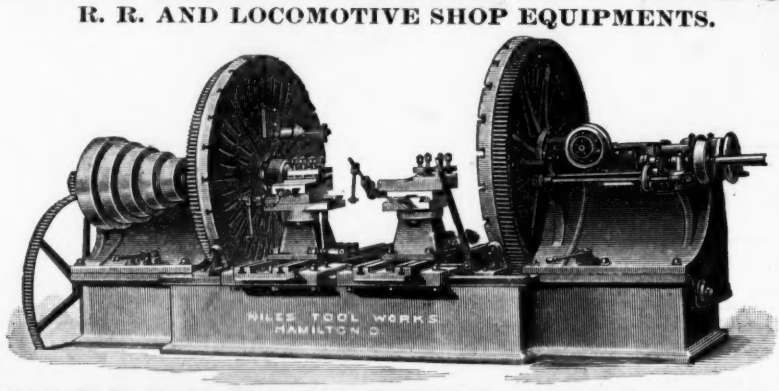
MANUFACTURERS OF BILLINGS' DROP FORGED LATHE DOGS FORGED FROM BEST STEEL FOR THE PURPOSE

IN 12 SIZES 3/8 UP TO AND INCLUDING 4 IN ALSO CLAMP AND DIE DOGS

DROP FORGINGS OF COPPER, IRON AND STEEL OF ALL DESCRIPTIONS.

DRIVING WHEEL LATHES.

R. R. AND LOCOMOTIVE SHOP EQUIPMENTS.



NILES TOOL WORKS,

HAMILTON, OHIO.

NEW YORK, 96 Liberty St.
PHILADELPHIA, 705 Arch St.
CHICAGO, 96 Lake St.

WARNER & SWASEY,

CLEVELAND, OHIO,

MACHINE TOOLS

For Iron and Brass Work.

SMALL TOOLS & FIXTURES.

Gear Cutting in all its Branches.

ILLUSTRATED CATALOGUE ON APPLICATION.

REMOVAL.

THE POND MACHINE TOOL COMPANY,

Formerly of Worcester, Mass.

The new shops of this company are located at Plainfield, N. J., forty minutes' ride from New York city on the line of the Central Railroad of N. J., and consist of the following:

A machine shop 500' long by 100' wide; a foundry 250' long by 90' wide; also commodious buildings for the storage of sand, coal, coke and pig iron; ample and convenient wash rooms for the men; fireproof two story pattern storage; blacksmith shop; engine and boiler houses. These buildings are detached from the machine shop and foundry. There is an elevated railroad for the convenient distribution of raw materials, and a railroad running through the machine shop for shipping. The whole plant is supplied with the incandescent system of electric lighting.

The machine shop and foundry have overhead traveling cranes running through their entire lengths; also light traveling cranes, which serve every tool, and a number of jib cranes in the foundry and scratch rooms. The foundry has capacity for making the heaviest class of castings.

All our tools are expressly designed for the economical manufacture of heavy machinery for railroad and general machine shop equipment, from new patterns of the latest and best designs.

SALESROOM and OFFICE, 111 & 113 Liberty St., N. Y. City.

NEW SHOPS, Plainfield, N. J.

CRANES

THE YALE & TOWNE MFG CO.
STAMFORD CONN
NEW YORK CHICAGO PHILA BOSTON

The Original Unvulcanized Packing

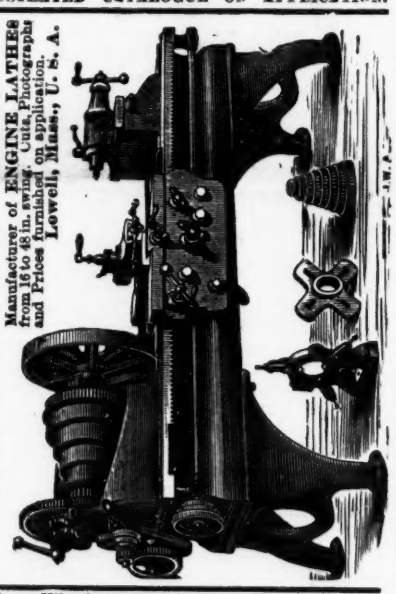
CALLED THE STANDARD—As it is the Packing by which all others are compared.

Accept no packing as JENKINS PACKING unless stamped with our "Trade Mark."

JENKINS BROS. { 71 JOHN STREET, N. Y. / 105 MILK STREET, BOSTON. / 21 NORTH FIFTH ST., PHILA. / 54 DEARBORN STREET, CHICAGO.

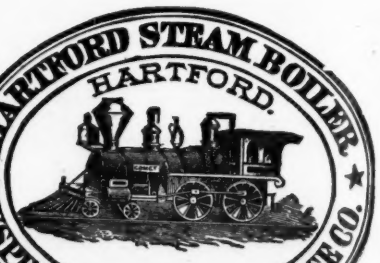
GEO. W. FIFIELD,

Manufacturer of ENGINE LATHES from 16 to 48 in. swing. Units. Photographs and Prices furnished on application.
Lowell, Mass., U. S. A.



Gear Wheels and Gear Cutting.—I make g to order, or cut teeth on g blanks sent to me. Of all kinds. Of all sizes to six ft. dm. Small orders or large ones. Fine g or cheap g. Small cast g. Ready made brass g by mail at low prices. Bevel g with perfect planed teeth. Hand Book on g, $1. Facilities complete. Terms reasonable. Send for cat.
GEO. B. GRANT, 66 Beverly St., Boston, Mass.

HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.



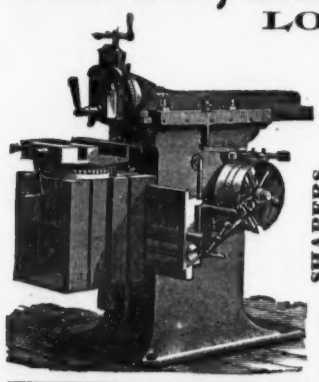
J. M. ALLEN, PRESIDENT.
W. B. FRANKLIN, VICE-PRESIDENT.
J. B. PIERCE, SECRETARY.

SHAPERS, ENGINE LATHES & DRILLS.

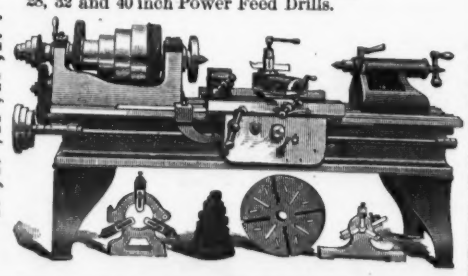
LODGE, DAVIS & CO.,

CINCINNATI, OHIO.

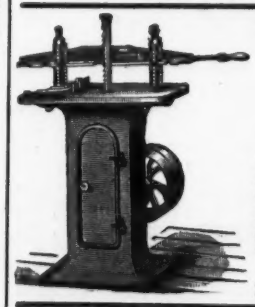
20 inch Upright Drills. 25 inch Back Geared.
24 " " " and
28, 32 and 40 inch Power Feed Drills.



SHAPERS, 8", 10", 15", 20", 26", 32" Stroke.
ENGINE LATHES, 17", 19", 21", 24", 27".



WRITE FOR PRICES, IT WILL PAY YOU.



KEY-SEATING MACHINES,

and 20-in. Drills

A SPECIALTY.

Our Key-Seating Machine will save enough in 60 days' use to pay first cost; no shop can afford to do without one. We have now ready for prompt shipment both Key-Seating Machines and 20-in. Drills. Send for Photo. and Catalogue.

W. P. DAVIS,
NORTH BLOOMFIELD, N. Y.

Lathes and Planers

FOR ALL PURPOSES.

The C. A. Gray Co.,

477, 479 & 481 Sycamore, cor. Webster. Cincinnati, Ohio.

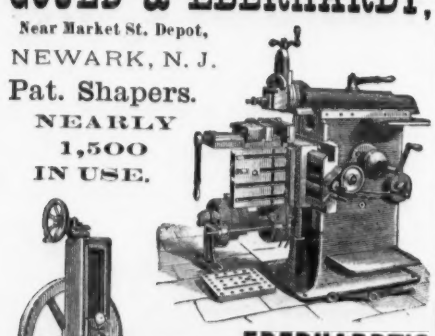
Photographs and prices sent upon application.

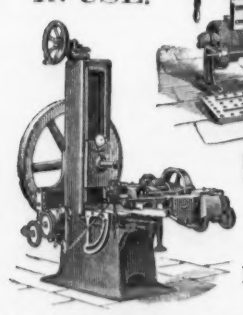
SEE ADVERTISEMENT, PAGE 13.

GOULD & EBERHARDT,

Near Market St. Depot,
NEWARK, N. J.

Pat. Shapers.
NEARLY 1,500 IN USE.





EBERHARDT'S Patent GEAR CUTTER.

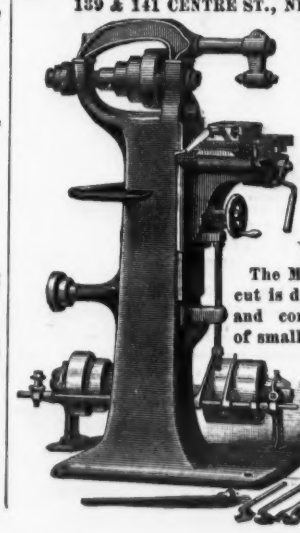
In Use throughout the World.

GEAR AND RACK CUTTING TO ORDER.

E. E. GARVIN & CO.

139 & 141 CENTRE ST., NEW YORK,

Manufacturers of MACHINISTS' TOOLS



Small Automatic Miller, WITH ARM.

The Machine shown in cut is designed for rapid and convenient milling of small work.

Send for Catalogue.

STEEL CASTINGS.

PRATT & LETCHWORTH
PROPRIETORS
Buffalo Steel Foundry,
BUFFALO, N. Y.

PUNCHING PRESSES, DIES,

And other Tools for the Manufacture of all kinds of

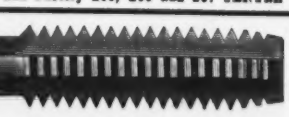
SHEET METAL GOODS, DROP FORGINGS, —ETC.— DROP HAMMERS.

STILES & PARKER PRESS CO.

MIDDLETOWN, CONN.

Branch Office and Factory 203, 205 and 207 CENTRE STREET, NEW YORK.

J. M. CARPENTER
PAWTUCKET, R. I.



Manufacturer —of— TAPS & DIES